Science Last Fortnight

Ginger Extract in Biofuel

Traditionally, ginger is used in many dishes. It is also consumed in beverages such as tea. According to folklore, ginger is good for us. Research appears to support some of these claims. Many studies focus on its antioxidant properties: it counteracts the effects of stress.

A team of scientists from the Tezpur University now report that the antioxidant property of ginger extract could be useful in the production of better biofuels.

Biodiesels are renewable, and biodegradable. But their oxidation stability poses a problem. The scientists used the antioxidant activity of ginger extract to increase the oxidation stability of *Pongamia pinnata* biodiesel.

The antioxidant activity of ginger extract is due to the presence of phenolic compounds. Scientists identified these compounds using standard techniques. They tested the antioxidant activity of different concentrations of ginger extract on Pongamia biofuel.

The results show that a minimum doping of 250 ppm of ginger extract in Pongamia biodiesel improves oxidation stability and meets standard specifications. Lower water content and a higher proportion of non-polar compounds in the ginger extract increased miscibility in biodiesel and improved performance.

Ginger extract is a low-cost and easily available additive to enhance the oxidation stability of biodiesel. Ginger, it seems, is as useful to the fuel in engines as it is to our body.

Fuel, **187**, 306–314

Nanosensor to Detect Milk Spoilage

Milk is highly perishable. Milk spoilage is difficult to measure with accuracy as there are no rapid methods for the precise detection of spoilage. The only rapid method which is available is called as clot on boiling method, which is widely used. However, the method detects the milk spoilage when the milk is already spoilt and it cannot be used anymore.

In the last fortnight a research team in the Pondicherry Central University reported development of a method based on silver nanoparticles to detect milk spoilage. Researchers used the lactic acid concentration in the milk produced by spoilage bacteria and acidity leading to spoilage as an indicator.

The team used silver nano particles bio-functionalized with cysteine as the sensor. Cysteine acts as a conjugating agent for nanoparticles and lactic acid. In the presence of lactic acid, cysteine induces aggregation of AgNPs leading to a change in colour of the AgNP from yellow to orange red to purple.

This method can be used as a rapid method for the detection of milk spoilage at pre-spoilage point. Other available methods like dye reduction test take at least two hours. Further they cannot be conducted under field conditions.

This method does not need expertise in handling and gives instant results. It can be developed into a portable kit. An Indian patent application is pending on the invention.

LWT-Food Sci. Tech., **75**, 702–709

Kudos for Kodo Millet

Kodo millet – *Paspalum scrobiculatum* – is an annual grain grown in India, the Philippines, Vietnam, Indonesia and West Africa. It is extremely hardy and drought tolerant. It can survive well on marginal soils where other crops fail. Scientific study of kodo millet's nutritional values and health benefits is, however, very meagre.

In the last fortnight, Sakshi Sharma and colleagues from the Dr Yashwant Singh Parmar University of Horticulture and Forestry, Himachal Pradesh, reported their study that overcomes the problem. The researchers collected grains from different districts of Himachal Pradesh and used chemical tests and chromatographic analysis to determine the percentage nutritional values of kodo millet grains. They also tested the antimicrobial activity of some of the chemicals present in the grains.

Researchers find that kodo millet grains are nutritionally rich. They contain more carbohydrates than wheat, rice and barley. The grains have total phenols, 18 times more than wheat and barley. The antioxidant activity of the grains is greater than that of wheat, rice and barley. Moreover, the grains are rich in minerals like magnesium and potassium as well as fibre content. As kudo millet grains are gluten free, food articles made with them can also be used by celiac patients who cannot consume wheat and barley.

The crop is only cultivated in a few states of India such as Himachal Pradesh and Tamil Nadu, and is consumed locally. Promoting large scale cultivation will ensure greater availability of this nutritious millet. It would also benefit farmers in rainfed areas.

Food Chemistry, **214**, 162–168

Jackfruit Peel
Promising pectin

The humble jackfruit – *Artocarpus heterophyllus* – is one of the most common fruits in India. Hailed as the 'poor man's fruit', the jackfruit is a popular ingredient in pickles, candies, ice creams and various other desserts. An average fruit weighs more than 20 kilograms, but a large part of this consists of the inedible husk and peel. The peel often goes as waste, as no efforts were made till date to create value added products from it. This is what sparked the interest of Prakash Maran and his team from Tamil Nadu. The researchers tested and optimized a process to extract pectin from discarded jackfruit peels.

Pectin, a polysaccharide, finds uses in many industrial processes. It is a major component of jams and jellies, many drug capsules and also acts as soluble dietary fibre.

A steady supply of waste jackfruit peel was available from the local fruit centre. The team washed, cleaned and processed the peel before milling it to a fine powder. The powder was then mixed with distilled water before exposing it to ultrasonic waves. This Ultrasound Assisted Extraction procedure is fast and efficient.

The team optimized the process by determining the best temperature, pH, sonication time and the ideal liquid to solid ratio so as to maximize the yield. Extraction at optimal conditions gave a pectin yield of 14.5% in dried weight.

Pectin is currently extracted industrially from the peels of citrus fruits and apple pomace, both of which are by-products of the fruit juice manufacturing industry. As jackfruit peel is ubiquitous and locally available, its effective utilization can create more income for farmers and food processors while cutting down on wastage.

Ultrasonics Sonochemistry, **34**, 525–530

Sericulture Silk

Polyamines promotes production

Silk is the cynosure of all eyes, especially for women. The triangular structure of the fibre gives it a glittering appearance. Silk is hydrophilic and amphiphilic – both water and fat loving – very similar to human skin. So it is biocompatible. Its oxygen and water vapour permeability promotes its wound-healing capacity. Given the demand from various quarters, scientists have come up with new ideas for sericulture.

Many attempts have been made to increase silk production by feeding the larvae with compounds such as royal jelly, a secretion of honey bee, cowpea, a legume. Juvenile hormones that regulate the physiology of the insects have also been used for promoting growth. Now, a group of scientists from the GITAM Institute of Science, Andhra Pradesh and the Centre for DNA Fingerprinting and Diagnostics, Hyderabad, suggest that treating the larvae with polyamine is a cost effective way to increase silk production.

Polyamines are aliphatic amines without aromatic carbon rings. Polyamines transfer protons to bind DNA and RNA under physiological conditions of the cell. Polyamines can thus regulate cellular protein synthesis and promote growth of the larval cells.

Polyamine-treated larvae show better gain in body weight, shell weight and hence more fibre production in the cocoon. Parameters such as crystallinity, percentage elongation and fibre diameter of the silk fibres also increased. Moreover, moisture regain capacity of the fibre was comparatively less.

The results imply that polyamine regulated growth of silk larvae would be beneficial for sericulture farms and textile industries.

Biopolymers, **107**(1), 20–27

Silk Bandages

Chitosan-silk for wound dressings

Silk scaffolds promote cell proliferation and tissue regeneration. For this reason, scientists are exploring silk as wound dressings. Among the available varieties, Tasar silk is most efficient in promoting tissue regeneration. But to date, non-woven silk matrices of Tasar silk could not be developed. Recently Purwar and his research team from the Delhi Technological University, devised a method to create non-woven Tasar silk matrices and combine it with chitosan to serve as wound dressings.

The researchers used silk from cocoons which were degummed, chopped and treated with formaldehyde to produce non-woven mats. Next, they washed the mats to remove salts before combining them with different concentrations of chitosan. Chitosan is a biodegradable polymer possessing antimicrobial activity. It also promotes blood clotting and cell adherence. By combining non-woven Tasar silk with chitosan, the researchers created a film bearing ideal properties for wound dressing. They tested the film for these properties using diverse techniques.

Results show that addition of chitosan did not affect the crystalline nature of silk fibers – which is necessary for tissue regeneration. In fact, it could increase the tensile strength three fold. The developed films had adequate porosity, water permeability and water retention capacity. The chitosan-coated films were biocompatible and more efficient in promoting cell proliferation than silk fibroin alone.

Due to the promising results obtained, the scientists now plan to study the effect of their chitosan–Tasar silk dressing and compare it to the commercially available wound dressings to evaluate its suitability in clinical settings.

J. Appl. Polym. Sci., **134**, 44341

Wound Dressings get a Makeover

Bamboo-silver nano-constructs

Tissue regeneration thrives in the presence of moisture and gaseous exchange. Therefore, scientists are experimenting with substances that can retain moisture to create new age wound dressings. Recently Yadav from the Institute of Himalayan Bioresource Technology, Himachal Pradesh, in association with scientists from the Academy of Sciences and Innovation Research, New Delhi, and the Center for Innovation and Applied Bioprocess, Mohali, tested bamboo cellulose nano-constructs for wound healing.

For constructing cellulose nanocrystals, the scientists used two varieties of bamboo plants – Tama bamboo and the Indian thorny bamboo. The leaves of these plants were treated with chemicals to rid them of non-cellulose contents. These were then reduced to a smaller size by mechanical means to

produce nano-cellulose crystals. Next, silver nanoparticles were synthesized and combined with cellulose. Silver nanoparticles have antimicrobial action and make wounds sterile. The Tama bamboo variant was found to contain silver nanoparticles of about 16 nm while the rough Indian bamboo featured 22 nm silver nanoparticles.

The nanocrystalline cellulose embedded with silver nanoparticles was then tested in both ointment form as well as hydrogel dressings. The tests evaluated the preparations on the basis of antibiotic potential, skin toxicity and wound healing in mice. The scientists found that addition of nanoconstructs could induce bacterial cell death within 6 h by promoting silver nanoparticle permeation within the bacterial cells. This was verified using sophisticated microscopic colorimetric and microbiology approaches.

The variant from Tama Bamboo was found to have a more potent antimicrobial action due to the presence of slightly smaller silver nanoparticles. Both the varieties were found to be non-cytotoxic on skin cells and could promote wound healing in less than 14 days by favouring collagen deposition, cell differentiation and angiogenesis.

The scientists are confident that their system is a promising candidate for developing new age wound dressings. Further testing in clinical settings may make bamboo leaves a valuable raw material for health industries.

Carbohydrate Polymers, **155**, 152–162

Heartbeat in Gelatin

Cardiovascular tissue engineering

Research on heart disorders essentially requires beating heart cells – a factor that has restricted innovation in this sector. Many scientists have used varying approaches to maintaining heart cells outside the body, but they seldom remain functional past two weeks. In the last fortnight, a team of research scholars from the Sri Ramachandra University, Chennai, have found a way to extend the *in vitro* heart cell survival to about a month.

Elamparithi and her team used gelatine nanoconstructs as matrices for heart cell culture. Gelatin is biodegradable, cheap and closely related to collagen – the protein which serves as cell matrix in hearts. The scientists prepared gelatin matrices by electrospinning a solution of gelatin in organic solvents. The fibres were collected and crosslinked with a carbodiimide to increase scaffold stability. The crosslinked matrix was then sterilized, characterized and assessed for cell culture suitability in 2D and 3D.

Even though initial cell adherence was slightly delayed in the 3D culture, the 3D gelatin constructs could support primary cardiomyocytes for over 27 days. However, in the 2D models, the cells stopped beating after 17 days. This was further verified by the marker for heart cells – troponin – and marker for contractility function – desmin.

The scientists found that these gelatin matrices could be stored for two months without any loss in morphology as assessed by electron microscopy. They are confident that the long-term 3D cell culture using cross-linked gelatin base can be employed for drug discoveries and *in vitro* physiological studies for assisting research.

Int. J. Polym. Mater. Polym. Biomater., **66**, 20–27

Arsenic Poisoning

Zebrafish model

Arsenic poisoning is one of the leading causes of death today. Even trace amounts are harmful. Arsenic can cause various conditions such as melanosis, keratosis, hyperpigmentation, etc. It is a potential carcinogen. But we have limited knowledge about the mechanism of action – which genes and proteins in our body are affected.

Last fortnight, scientists at the University of Delhi proposed zebrafish as a model to study arsenic poisoning. As a beginning, they assessed changes in the immune system and related genes due to arsenic poisoning.

They exposed zebrafish to increasing concentrations of arsenic for a month. After the exposure period, fish were infected with a pathogenic bacteria – *Aeromonas hydrophila*. Pathogenicity was 11–15 times more in arsenic poisoned fish. The kidneys of exposed fish were severely damaged.

The researchers measured the expression of genes related to the immune system. They saw that the genes were either over or under expressed compared to the controls. These genes code for proteins which are critical signalling molecules and mediators in immune system functioning.

Zebrafish and humans have a similar genetic makeup. Thus they can be used as a model system to understand the mechanism of action of various heavy metals, toxins and drugs. This research has taken one more step towards understanding the mechanisms behind arsenic poisoning and has given valuable information about the proteins affected in the immune system.

J. Hazardous Mater., **321**, 121–131

Wild Edible Fruits

Nutraceutical potential

The Himalayan region is breathtaking. However, the lack of agricultural biodiversity, crucial to food security, is of concern. Harsh conditions and extreme altitudes prevent the use of many standard crops in this region. So, identifying crops that can adapt is a challenge for farmers.

Bhatt and his group from the National Institute of Himalayan Environment and Sustainable Development, Uttarakhand, studied the nutraceutical properties of ten Himalayan plant species. They reported that the wild edible fruit plants of the region are rich sources of various antioxidant compounds. Myrobalan, Indian gooseberry, *Morus alba*, *Ficus palmata*, Nepalese firethorn, *Berberis asiatica* and Bayberry are the richest sources of phenolics, flavonoids, ascorbic acid, β-carotene and anthocyanins. Phenolic compounds varied among species. Myrobalan and Indian gooseberry had the maximum. The antioxidative property of these plants helps reduce free radicals in the body, thus preventing diseases such as cancer, scurvy, etc.

These fruit trees are naturally adaptable to the Himalayan climate and can supplement the dietary needs of the people. Thus they help overcome nutritional insecurity in the Himalayan region. The nutraceutical properties make the trees attractive to drug industries. Thus these trees provide an additional opportunity for a livelihood. Scientists advise planting them in the bunds of agricultural fields as well as in wastelands.

Food Chemistry, **215**, 84–91

Economic Inequality

A new measure

Economic inequality has a negative effect on human potential, well-being and happiness. Quantifying inequality is vital in measuring the success of schemes designed to reduce it, and in comparing societies to find ones worth emulating.

Economic inequality is usually measured using the Gini index, which is a number varying from 0 (perfect equality) to 1 (complete inequality). Germany, for example, had a Gini index of 0.301 while India had 0.351 and South Africa 0.634 (income data from World Bank, 2011).

Though widely used, the Gini (g) index has some disadvantages. It is difficult to calculate. We need to know the total assets of all the individuals in a society. Moreover, even small errors in the input will inevitably skew the result.

Researchers from the Saha Institute of Nuclear Physics, Kolkata and the Aalto University, Finland, have developed an easy way to measure inequality. This Kolkata (k) index is the fraction of total wealth that is held by (100-k) per cent of the population. It varies from 0.5 to 1.

This makes calculations easier. We need to know only the wealth of the richest person, the number of people in the community and the assets of certain, usually middle-class, individuals. These are easier to obtain or estimate than the assets of poorer people, which are rarely recorded. Moreover, errors in all but a few data points have no effect on the final result.

Roughly, the Gini and Kolkata indices are related by the equation $k = 0.5 + gc$, where $c = 0.365 \pm 0.005$ and $g < 0.7$.

The scientists point out that the Kolkata index of inequality is not limited to wealth, but can be used to make sense of various other types of data, such as citations per paper and city populations.

The usefulness of indices like this will be based on the contribution they make in reducing economic inequality to the low levels seen in countries like Norway and Slovenia.

PHYSICA A – Stat. Mechan. Appl., **466**, 583–595

Elephant Foot Yam

A food preservative?

Elephant Foot Yam – *Amorphophallus konjac* – is a perennial, tropical tuberous root crop grown in Asian countries. It has a bland flavour and is considered a cheap vegetable with good nutritional values. *A. konjac* corms are rich in starch, vitamins, minerals and glucomannan.

Glucomannan extracted from the *A. konjac* tuber is a water soluble polysaccharide which functions as storage macromolecules. It swells and forms a gel. It is a low caloric dietary fibre and has important health benefits. It is a naturally occurring low glycemic carbohydrate source and has many favourable features for the food industry. A review of literature in the field, published last fortnight, covers the applications of glucomannan from elephant foot yam.

Konjac starch is superior to potato or maize starch. Crude Konjac flour is a low-calorie food supplement with several therapeutic applications.

Konjac glucomannan as a food preservative draws the attention of researchers as it is cheaper, convenient, and has obvious advantages over conventional food preservation methods.

To improve the quality and acceptability of glucomannan, yam goes through bioprocessing. Processed konjac foods are popular in Asian markets. They are used as fat analogues in various meat products including fresh pork sausages and merguez sausages.

The review identifies the gaps in our understanding. *A. konjac* is a major vegetable (tuber) crop. It belongs to the Araceae family with 170 member species, mostly wild. Only a few are edible and are domesticated. Research directed to uncovering the relative nutritional and other merits of the members of the group may yield more useful results.

Food Rev. Int., **33**(1), 22–43

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Science Last Fortnight

Sulphur Mustard

Decontaminating with nanoparticles

Sulphur mustard, a deadly World War I chemical warfare agent, now threatens to resurface in the hands of terrorists. Inhalation, ingestion or skin contact results in blisters and burning. Scientists have been seeking to decontaminate it. Last fortnight, Kumar and colleagues, from the DRDO Establishment, Jhansi, devised a solution.

They tested Mg, Ca, Mn, Co, Ni, Cu, Zn and Mn–Zn, Co–Zn mixed metal ferrite nanoparticles on sulphur mustard. The researchers used the co-precipitation method for nanoparticle synthesis. Ni, Zn and Co–Zn ferrite nanoparticles exhibited high decontamination: 99.99% of sulphur mustard within 10 h of treatment.

Gas chromatography coupled with mass spectrometry data indicated that the nanoparticles convert toxic sulphur mustard into non-toxic products. Basic sites and Lewis acid sites were responsible for the decontamination properties of nanoparticles, as confirmed by CO_2 and NH_3 temperature programmed desorption.

Ni, Zn and Co–Zn ferrite nanoparticles show significant reactivity towards sulphur mustard and high adsorption capacity. These findings suggest their application in decontamination kits.

J. Alloys Compounds, **692**, 833–840

Detecting Duplication

Diagnosing leukemia

B-cell acute lymphoblastic leukemia is a blood cancer with poor prognosis. Gene duplication and deletion are frequently noticed in patients.

Last fortnight, Gupta and team from AIIMS, New Delhi, reported the prevalence of copy number alterations and its clinical correlation in B-cell acute lymphoblastic leukemia patients. Analysis of gene copy number alterations is done by the multiplex ligation-dependent probe amplification assay. The scientists tested 162 patients for any copy number alterations of the genes. They observed copy number alterations in 114 cases. Based on copy number alteration profile, patients were classified into high and poor risk categories. Interestingly, at least one of the tested genes showed copy number alteration.

The copy number alterations were higher in older patients. The researchers found a significantly higher incidence of chemotherapy failure in some patients with the deletion of Retinoblastoma 1 and Ikaros family zinc finger 1 genes.

Thus, detection of copy number alterations of genes related to B-cell lymphoblasts will help diagnose or even predict this disease to some extent. This improves informed treatment decisions and, hence, chances of disease recovery.

Leukemia & Lymphoma, **58**(2), 333–342

Detect Melamine in Milk

Do it in the kitchen

In the 2008 Chinese milk scandal, at least six infants died and thousands were hospitalized. They consumed milk products which were adulterated with melamine. It leads to kidney stones and renal problems in infants and adults. Compounds like melamine and urea bulk up apparent protein content. These adulterants are difficult to detect. So scientists have been looking for rapid and accurate techniques.

Last fortnight, two independent research groups made transformative strides in developing such techniques. Madeswari Ezhilan and associates from the SASTRA University, came up with an enzyme-based biosensor, which detects melamine and urea in millimoles[1].

The biosensor is fabricated with zinc oxide, and modified with platinum electrodes. Acetyl cholinesterase (AChE) was used as the primary target for inhibition. Melamine and urea block the serine hydroxyl group of AChE. The extent of blocking depends on the concentration of the melamine. The metal electrode in the sensor measures this activity.

While Madeswari focused on the aggregation of the nanoparticles, Kiruba Daniels and team from the Indian Institute of Science, Bengaluru, concentrated on the size and shape of the nanoparticles[2]. They used a *Parthenium* extract, a reducing agent, to detect melamine. The extract interferes with synthesis when it forms nanoparticles. This gives a visible colour change when melamine is present.

Both teams have a simple goal in mind: to develop low cost and accurate techniques. These methods detect the compounds rapidly and can also identify selectively. Biosensors are also used for monitoring glucose and a similar design can work for milk detection too. Interestingly, Daniels and his team have even filed a patent and plan to commercialize the process. Soon, instead of going to labs, we can test milk purity in the kitchen too.

[1]*Sensors and Actuators B*, **238,** 1283–1292

[2]*Sensors and Actuators B*, **238**, 641–650

Surveying Sunflower Productivity

Genetic diversity as solution

Sunflower is an introduced edible oilseed crop, popular with Indian farmers. A major limitation in its cultivation is its susceptibility to diseases. Especially, leaf blight, caused by *Alternariaster helianthi*, a fungal infection that produces spots on the leaves. The result: reduced seed and oil yield. The infection is more common during the rains, and at times occurs in epidemic proportions. This discourages farmers from cultivating the crop.

Santha Lakshmi Prasad and team, from the ICAR-Indian Institute of Oilseeds Research, Hyderabad, hypothesized that low genetic diversity was the prime reason for susceptibility to such infections. The team undertook a five-year study to identify new and diverse sources of *Helianthus*, resistant to blight. The sources included wild *Helianthus* species, interspecific derivatives, superior lines and exotic germplasm. They employed two different assay methods, a detached leaf technique and the whole plant assay method to screen the plants. The plants were tested under glass house conditions against three strains of *A. helianthi*.

Under lab conditions, wild *Helianthus* species showed resistance to leaf blight. Crosses of cultivated sunflower with the wild ones showed better resistance to the disease. Field studies revealed varying expressions of resistance under different environmental conditions. Six accessions showed low leaf blight severity across locations. These lines can help develop sunflower hybrids with inbuilt resistance to leaf blight.

This intensive study can serve as a baseline for sunflower breeders in developing new cultivars. It emphasizes the need to exercise caution while introducing new species and stresses the importance of a broad genetic base for crop improvement.

Crop Protection, **92**, 70–78

Bacteria to Boost Agriculture

An unexplored reservoir

The Himalayan region has many well-known biodiversity hotspots. Though rich in ecological diversity, it suffers low agricultural productivity due to difficulties in cultivating on small landholdings at high altitudes where water runoff is fast.

Ragi, *Eleusine coracana* L., is one of the main food grain crops cultivated here. This particular crop is known for its ability to withstand water stress.

A team of scientists led by Dheeman from the Gurukul Kangri University, Haridwar, in collaboration with scientists from the Republic of Korea, explored the ecological diversity of bacilli growing in difficult environments for improving agricultural production in the Himalayan tract.

The researchers studied the diversity of the *Bacillus* population associated with ragi. They analysed the functional ecology in relation to plant growth promoting attributes. The team used two universal primers derived from the highly conserved region of 16S rRNA gene *fD1* and *rD1* for species identification. They studied the site-specific diversity of the bacterial strains using the Simpson and Shannon–Wiener index.

The team confirmed the suitability of 48 isolates of aerobic endospore forming *Bacillus* spp. from the rhizosphere of ragi. The functional traits of the *Bacillus* species exhibited direct or indirect impact on plant growth. The isolates showed metabolic diversity in the use of various carbon and nitrogen sources. Phylogenetic analysis of the isolates revealed three species in the *Bacillus* genera and two in *Paenibacillus* genera.

Among the strains, more than 90% of bacilli were phosphate solubilizers, more than 70% auxin producers, 70% biocontrol agents and about 50% isolates produced hydrocyanic acid. The site-specific diversity and density of culturable bacteria showed positive correlation with the altitude gradient.

The rich reservoir of *Bacillus* spp. provides an opportunity for the development of bioformulations to improve agricultural production in other similar problematic sites.

Applied Soil Ecology, **110**, 127–136

Humic Acid in Vermicompost

Vermicompost has gained popularity as an alternative to chemical fertilizers which have proved harmful. It serves as a source of nutrients for microorganisms that promote indigenous microbial communities, increasing overall microbial growth. However, organic manures can be further enriched and improved to boost agricultural productivity.

It is well known that microbial activity can improve organic manure. Maji and team, at the CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, examined microbial diversity in soils subjected to different fertilizers with and without humic acid, a compound that supports plant growth and tolerance to stress.

The researchers inoculated vermicompost, made from rice straw wastes and cow dung, with *Trichoderma atroviride* RVF3, a fungal strain. And they assessed the growth and yield of *Pisum sativum* plants along with microbial population dynamics.

Plants treated with humic acid-rich vermicompost show maximum shoot length, root weight, height, higher nodulation, more colonies of cultivable microorganisms and the highest microbial diversity. And soil treated with humic acid-rich vermicompost shows the highest microbial biomass carbon and nitrogen as well as enzyme activity.

They conducted a second set of experiments using inoculums of *Rhizobium leguminosarum* and arbuscular mycorrhizal fungi, applied alone or in combination with one of the fertilizers: chemical fertilizer, normal vermicompost and humic acid-rich vermicompost.

Plants treated with both rhizobia and arbuscular mycorrhizal fungi along with humic acid-rich vermicompost show maximum shoot and root length, fresh weight as well as improved root nodulation and AMF colonization.

Humic acid thus improves vermicompost by enhancing the performance of diverse beneficial microbial populations. Scientists are now planning to carry out next generation sequencing to estimate true microbial diversity and the role of microorganisms in shaping the structure of the community in the soil.

Applied Soil Ecology, **110**, 97–108

Extracting Oleoresins from Ginger

Ultrasound and enzyme pretreatment

Ginger is a popular spice with many health benefits. These pharmacological effects are due to the gingerols and shogaols of its oleoresin. Conventionally, they are extracted using Soxhlet and cold percolation. However, these methods require longer extraction time, more organic solvents and also expose the extract to degradation or modification. Hence, alternative methods were developed. But these come with high investment and maintenance costs.

To overcome this, three phase partitioning was developed. When cell homogenates are mixed with *t*-butanol and aqueous ammonium sulphate, they form three layers, separating polar constituents, proteins and hydrophobic constituents. The oleoresins are separated at the interphase of the organic and aqueous layer.

Last fortnight, Varakumar, Umesh and Singhal from the Institute of Chemical Technology, Mumbai, explored the effect of enzyme and ultrasound pretreatments on this separation technique.

The scientists prepared rhizome powder and optimized the conditions for maximum extraction of oleoresin by three phase partitioning. Though this yielded more gingerols, 6-shogaol yield

decreased. Ultrasound pretreatment increases oleoresin yield. But it imposes constraints in scale-up.

More oleoresins can be extracted using amylase and cellulase treatments before three phase partitioning. The process takes less than 4 h, unlike conventional methods that require more than 12 h. Therefore, scientists claim that the enzyme-assisted three phase partitioning can be a promising approach for ginger oleoresin extraction. Such scaling-up can be commercially viable.

Food Chemistry, **216**, 27–36

Smartphones Detect Salinity

Salinity is an important parameter for monitoring marine environments. Marine species adapt to certain salinity levels. Changes in salinity affect marine populations and ecology. So measurement of salinity is relevant for fishermen and scientists alike.

Scientists at the Tezpur University have now developed two smartphone-based systems to estimate the salinity level of sea water. The first technique is based on the Beer-Lambert principle: the intensity of the transmitted light depends on the concentration of the medium. The second is based on evanescent field absorption from a U-shaped fiber optic sensor.

The scientists prepared solutions of different concentrations of artificial sea salt, containing all the minerals found in a real oceanic environment. They used two freely available android applications, 'light meter' and 'stanXY', for data acquisition and analysis to standardize the measurements. Now, using a simple optical set-up and these two free applications, the salinity of any unknown sample can easily be estimated.

The performance of both the techniques was compared in terms of sensitivity, reproducibility and dynamic range. Among the two schemes, the linearity in sensor response for U-shaped fibre probe is found to be better than the first scheme in the salinity range 0–1 ppt. Unclad U-shaped fibre probes offer higher sensitivity than that provided by absorption sensors.

These smartphone-based measurements of salinity are useful as field data from remote locations can be easily transmitted to a central laboratory through existing mobile networks for continuous monitoring.

Sensors and Actuators B. Chemical, **239**, 1042–1050

Renewable Energy

A business for farmers?

India has the ambitious target of achieving a 175 GW capacity of non-fossil fuel-based energy by 2022. Any strategy to access private farm lands would be of great advantage for this target. Land, though, is a major bottleneck for setting up renewable energy projects.

In recent years, community energy models have achieved great success in countries such as Germany, Denmark, Austria, Scotland and the US. But, for India, the demographic and socio-economic profile is significantly different. The challenge, therefore, is to build a business model that works for Indian conditions.

Last fortnight, a team of researchers from the Indian Institute of Technology, New Delhi, addressed the issue. They derived a business model where farmers can become co-owners by offering their land for energy production. The reward? A constant source of income estimated at about Rs 270,000 per hectare per annum.

In the proposed model, farmers can participate in renewable energy production under a joint venture company and earn by providing labour for upkeep. The usual cost incurred in procuring land and its development for a renewable energy project is estimated to be up to 10% of the total project cost. This cost will be reduced up to 6% when farmers share their land.

The ownership of the farmers would be limited to land and development costs. The remaining shareholding will lie with the project proponent. The proponent–farmer joint company can sell power to a nearby grid.

Already, India has many success stories of community participation in the dairy and sugar sectors. This new model will enable policy makers to enhance India's energy security. For farmers, this spells better access to energy and an additional source of income.

Renewable Energy, **101**, 873–885

Better Biodiesel

A nano-cleansing solution

Biodiesel is a sulphur-free renewable fuel with a fuel value comparable to petroleum derivatives. However, producing biodiesel that adheres to international standards has proved difficult using current technology. The presence of impurities like soap, residual catalyst, free fatty acids and metal ions are detrimental to the efficient operation of diesel engines.

Last fortnight, researchers, from the Central University of Gujarat, reported a novel solution for the problem. They designed polyurethane-functionalized starch nanoparticles. These nanoparticles have large surface area, surface volume and porosity at the nano-level, making them ideal adsorbents. Moreover, they are biodegradable.

Dhananjay Mondal and team synthesized fresh biodiesel from Karanja (*Pongamia pinnata)* oil, using acid catalysed transesterification. They designed two classes of polyurethanes – nano-polyurethanes and bulk-polyurethanes – and challenged them with partially purified biodiesel. The adsorbents were graded on their ability to reduce the levels of free fatty acids, a major contaminant in the partially purified fuel mix. The team showed that nano-polyurethanes were much more efficient than bulk polyurethanes.

The use of adsorbents in the purification of biodiesel can help reduce the use of solvents currently deployed in the wet washing process, an inefficient and wasteful technique. The adoption of the new technique by industry could lead to a substantial reduction in water consumption.

J. Appl. Polym. Sci., **134**, 44463

Swamp Dwellers to Sugar-makers

Streptomyces olivaceus

Technologies to replace fossil fuels with renewable biofuels such as ethanol have been gaining momentum. Unfortunately, modern methods of ethanol production use high quality crops such as corn, leading to increased price and causing food shortage while consuming valuable farm and forest land[1]. This can be avoided if ethanol can be produced from organic wastes.

Next to cellulose, hemicellulose is the most abundant renewable biomass. It mainly contains xylan, a sugar which can also be used for bioethanol production. Bacteria and fungi, particularly actinomycetes like *Streptomyces*, are natural producers of xylanase, an enzyme that can convert xylan to alcohol.

Actinomycetes are usually collected from soil and in the water and floor of streams and lakes. Last fortnight, Muthusamy Sanjivkumar and coworkers,

from the MS University and the Periyar University, reported a new source of xylanase[2]. They isolated several *Streptomyces* species from the sediments of mangrove forests in the Manakudy estuary of southern Tamil Nadu. Of these, *S. olivaceus* was found to give the highest xylanase yield. The highest xylanase yield was reported at pH 7 and 40°C, using sucrose as carbon source and yeast extract as nitrogen source.

The xylanase gene of *S. olivaceus* was similar to those from other related species. The researchers isolated and purified the enzyme protein and its properties and activity were studied. It was found to give good yields for sugarcane juice, sugarcane bagasse (2.47 g/l at 72 h), vegetable waste, mango peels and banana waste.

If bioethanol can be economically produced from waste materials such as bagasse, it can replace fossil fuels such as petrol and environmentally and socially harmful alternatives such as corn-based ethanol.

[1]*Environ. Health Perspectives*, **116**(6), A254–A257

[2]*Protein Expression and Purification*, **130**, 1–12

Nullifying Noise

Unwanted noise sometimes mars our enjoyment of radio or TV. Receivers use a noise control mechanism to nullify primary noise, but secondary noise, a non-Gaussian distribution, remains.

Scientists, from IIT Gandhinagar, have devised an efficient nonlinear Active Noise Control scheme using an information theory approach.

Active noise control is based on destructive superposition and is achieved using a microphone, loudspeaker and adaptive controller. A smaller distribution of signals results in highly impulsive noise signals.

The team used an adaptive FIR filter which minimized costs. For dealing with nonlinearity in noise, a nonlinear functional artificial network filter is used as controller. The change in the parameters of the 'filtered mean square algorithm' is directly proportional to the magnitude of error signal.

To tackle this, the researchers came up with the notion of 'correntropy', the correlation between two variables in a small neighbourhood. They used adaptive filters which minimize the mean square error and maximize the correntropy. The robustness of the algorithm lies in the fact that the parameters become constant – derivative becomes zero – for a high magnitude of error. This has been found to work even for non-Gaussian noise, giving faster convergence.

The validity of these noise reduction techniques was tested using MATLAB simulations.

These techniques can lead to a more sensitive controller output transmitter and help customers get the desired signal with robust noise cancellation ability.

Applied Acoustics, **117**, 180–184

Reports by: **Shailesh Pandey, Manish Kumar Tekam, S. Arun, Anubhab Dey, V. Baskar, Jose Mathew, M. Rajkumar, G. Anuradha, Subhashini, A. C. Surya Prabha, Tresa Hamalton, S. Dhivya** and **Rekha R. Warrier**

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Science Last Fortnight

Duckweeds as Human Food

Wolfing down Wolffia

There are a large number of ponds in Kerala. And duckweeds grow plentiful in freshwater. They are known to be rich in proteins with essential acid composition close to WHO recommendations. Moreover, they contain omega-3 fatty acids, a neutraceutical of great value.

But then there are a large number of duckweeds. They belong to five distinct genera of the Limnacea family: *Spirodela*, *Landoltia*, *Lemna*, *Wolffiella* and *Wolffia*. Sowjanya Sree, at the Central University of Kerala, collaborated with German scientists to find out which is the best for human consumption.

The starch content of duckweeds ranged from 4% to 10%. But protein content was high – 20–35% per dry weight. Duckweed total fat is rich in the *n*3 α-linolenic acid, which results in low *n*6/*n*3 ratios. *W. microscopica* and *W. hyaline* had the highest amounts of essential acids. In comparison to other vegetarian foods, duckweeds also showed very high concentrations of antioxidants, lutein and zeaxanthin. Phytosterols, known to lower plasma cholesterol and LDL cholesterol, are also high – 5 times higher than in most other plant oils.

Duckweeds, especially species belonging to *Wolffia*, have been traditionally eaten in South East Asia as salad, mixed in soups or curries or in omelettes.

W. microscopica is the fastest growing angiosperm known till date. *Wolffiella* species has the potential to reduce protein and other nutritional deficiencies in the country, if the Indian public accepts these weeds as food items.

Food Chemistry, **217**, 266

Unified Marker

For detecting milk adulteration

In 2012, the national survey conducted by the FSSAI disclosed that 70% of milk adulteration occurs due to chemicals, detergents, skim milk powder and impure water. The identification of these adulterants is difficult because of lack of standardized techniques. Scientists from the Indian Institute of Technology, Hyderabad, Telangana, proposed a 'unified universal marker' for the detection of adulteration in milk.

The research team aimed at examining the inherent biophysical properties of milk for the detection of adulteration and for quality profiling. They collected fresh cow milk samples from several local sources and determined the initial threshold values for impedance and pH. They monitored the effect of multiple adulterants under electrical conductivity and pH simultaneously. They also performed spectroscopic studies using fabricated gold electrodes on glass substrate for developing a multiplex lab-on-chip miniaturized platform. It was found that parameters like electrical conductivity and pH were efficient as unified markers. However, the study required a 'safe range' estimate for each selected marker to develop a tamper-proof system.

Indeed, analysis through biophysical parameters acted as potential universal markers in comparison to the traditional adulterant-specific approaches. Perhaps, further studies will provide more insights.

Food Chemistry, **217**, 756–765

The Golden Solution

Testing water purity with gold

Malachite green is a dye which finds use in aquaculture due to its antimicrobial properties. Even at low levels, this dye is toxic to humans. But, due to low-cost and easy availability, it is still used by many aquaculture farms. Now, John and his student from the Gandhigram Rural Institute, Tamil Nadu, report a simple inexpensive technique to detect malachite green in water.

Gold nanoparticles possess remarkable optical properties and show strong surface plasmon resonance. As a result, solutions with different sizes of gold nanoparticles have different colours. For instance, a solution of small gold nanoparticles is usually wine red. But when these nanoparticles aggregate, they absorb longer wavelengths of incident light changing the colour of the solution to deep violet. The scientists made use of this property for devising a simple dye detecting strategy.

They capped the gold nanoparticles with 3,5-diamino-1,2,4-triazole to create stable amine functionalized nanoparticles. Addition of malachite green creates strong electrostatic interaction between the ammonium ion of the dye and the free amine group of the amine-functionalized nanoparticle. This induces aggregation. The colour of the amine-functionalized gold nanoparticle solution changes from wine red to deep violet. The colour change is so pronounced that it can be detected by the naked eye if the dye concentration is more than 25 micromoles.

Scientists also demonstrated the practical application of this technique in water collected from fish farms. The low-cost, rapid response time and simplicity make this method viable for routine monitoring of malachite green in aquaculture facilities.

Spectrochimica Acta Part A, **173**, 837–842

Geographical Identity of Basmati

Isotopes as tracing tools

Basmati holds a special place in the international market for its distinct aroma and superior flavour. The increasing demand for Indian Basmati in the global market has led to adulteration with rice from other regions. The geographical origin of rice can be established using multi-element patterns and isotopic composition. Indian Basmati, however, lacked such a database.

Last fortnight, R. A. Lagad and team, from the Physical Research Laboratory, Ahmedabad, reported the development of a database of $^{87}Sr/^{86}Sr$ ratio and rare earth element composition for Indian Basmati rice.

The team collected plant, soil and water samples from various localities of the Indo-Gangetic Plain. They analysed the composition of strontium, rubidium and rare earth elements in the plants and soils. There was significant variation in the concentrations of strontium and rubidium in rice samples and a strong correlation between the concentrations of rare earth elements in rice and in the soil in which it was grown.

The team also determined the isotopic ratio of strontium in rice grain, soil and water samples. The $^{87}Sr/^{86}Sr$ ratio of rice samples is within the range of authentic Basmati. The silicate fraction of the soil had a higher $^{87}Sr/^{86}Sr$ ratio than the carbonate fraction. Scientists also examined the possible source of strontium in rice plants. It appears that irrigation water is the main source of strontium in rice. Thus, the higher $^{87}Sr/^{86}Sr$ ratio in Indian Basmati rice is attributable to the river Ganga whose water is used for irrigation.

The scientists believe that the database on $^{87}Sr/^{86}Sr$ ratio and rare earth element composition would help identify Basmati of Indian origin. We can thus eliminate adulteration and help customers get genuine Basmati.

Food Chemistry, **217**, 254–265

Are you being Drugged?

Paper chip test for ketamine

Ketamine is used as anesthetic for children and as sedative for painful medical procedures. But, recently, the drug has been implicated in date rapes. To make matters worse, current methods for ketamine detection are time-consuming and expensive. Scientists have now found a way around this problem by creating an inexpensive paper-based microfluidic device.

In their model, Narang and Malhotra, from the Amity University, Noida, used a combination of zeolite nanocrystals and graphite oxide nanoflakes as detectors and connected it to carbon ink printed electrodes. The pattern for the entire assembly was first created as a stencil and then printed on Whatman paper. Next, the setup was tested for ketamine detection using electrochemical method.

Liquids containing different quantities of ketamine were added to the zeolite-graphite oxide nano-detector and voltage was varied from –2 to +2 mV to detect the current produced from the electrodes. Liquids with a higher amount of ketamine produced greater current flow. The device was found to be extremely specific for the drug and could detect quantities in the range of 0.001 to 5 nM/ml.

Most established methods for drug detection are based on changes in pH and can be affected by environmental conditions. Since this method is based on electrochemistry, it has greater sensitivity. Additionally, the paper chip is economical, stable for almost two months and can be reused without any significant loss in performance. Scientists are confident that this device will greatly improve ketamine detection, especially in developing countries.

Biosensors & Bioelectronics, **88**, 249–257

Nanodetection of Insecticides

Insecticides are applied to plants for increasing productivity. Most of the pesticides applied are not easily degradable. They persist in soil, leach to groundwater and surface water and contaminate the environment. Depending on their chemical properties, they can enter the organism, accumulate in food chains and, consequently, influence health. Some pesticides still defy detection because existing methods are costly and time consuming.

Terbufos and thiacloprid are harmful insecticides extensively used for agriculture. Conventional methods of detecting these insecticides are used at high concentrations and drastic reaction conditions. Detection using these methods also suffers from various interferences which makes the screening difficult.

Last fortnight, Kailasa and team, from the S. V. National Institute of Technology, Surat, formulated a simple colorimetric method for the selective detection of terbufos and thiacloprid insecticides. They used gold nanoparticles with a nitro and hydroxy benzyl-indole-dithiocarbamate derivative, a red coloured aggregate, as probe.

The team collected tap, river and canal water samples from the Department of Applied Chemistry, the Tapi River and the agriculture canal, Surat, India. They spiked these samples with various concentrations of insecticides. They also used corn, sorghum, tomato and apple samples, fortified with different concentrations of insecticides, for the experiment. When tested on these samples, the probes turned from red to blue.

In food and environmental pollution control laboratories, this serves as a simple, selective and sensitive colorimetric method for detecting even trace amounts of terbufos and thiacloprid contaminants.

Colloids and Surfaces, **515**, 50–61

Hibiscus Leaves

Potential for pigments

Inorganic materials used in photonic and optoelectronic devices have large nonlinear refractive index. But they require expensive and high power lasers to provide nonlinear optical effects. Therefore, natural dyes and organic molecules are being investigated for their potential use in nonlinear optics. Naturally occurring dyes like chlorophyll, carotenoid, etc. have a large nonlinear refractive index and can provide nonlinear optical effects with low power lasers. Hence, they are better alternatives to the inorganic materials that are already in use.

Last fortnight, scientists from the National Institute of Technology, Durgapur, extracted a natural pigment, with high nonlinear refractive index,

from an evergreen plant: *Hibiscus rosa-sinensis*. The scientists extracted pigments from the leaves by column chromatography. UV-Visible absorption spectroscopic analysis revealed that the extract contained 56% chlorophyll-*a*, 25% chlorophyll-*b* and 19% carotenoid.

Analysis of photoluminescence intensity showed that the extracted pigments exhibit stable photoluminescence emission characteristics.

The researchers examined the nonlinear optical properties of the natural pigment by spatial self-phase modulation using a low power CW He–Ne laser of wavelength 632.8 nm, with a maximum power of 5 mW as pump light. The nonlinear refractive index of the pigment extract was 3.5×10^{-5} cm^2/W. This value is larger than even those of some 2D materials, such as MoS_2, $MoSe_2$, etc., reported earlier! This property is attributed to the asymmetrical structure of chlorophyll, molecular reorientation and thermally induced nonlinearity in the sample.

This work opens new avenues for the economical synthesis of organic dyes with large nonlinear optical properties. They are promising candidates for use in optical communication, data storage, optical limiting devices, etc. With their high value of nonlinear refractive index and photostability, these pigments can be used in nonlinear optical microscopy to stain biological molecules for improved imaging contrast.

Spectrochimica Acta Part A, **173**, 400–406

Lens-Free Real-Time Imaging

Detecting toxic aluminium

Aluminium is the third most abundant metallic element in the lithosphere. Accumulation of aluminium in the body causes neurotoxicity and is implicated in the development of Alzheimer's and Parkinson's diseases. It also causes amyotrophic lateral sclerosis and chronic renal failure. The detection and quantification of aluminium have been a problem due to the strong hydration capacity of aluminium in aqueous media. This leads to weak coordination among aluminium molecules. *In vivo* detection of aluminium in the biological system is even more difficult.

Lens-free real-time live cell imaging is a simple, non-invasive method for assessing the biological activities of different elements. Last fortnight, researchers at the North Eastern Hill University, Meghalaya, reported the development of a new coumarin-based Schiff base compound as a probe to detect aluminium in living cells. They synthesized the coumarin-based Schiff base by adding salicylaldehyde dropwise to 3-amino-4-hydroxycoumarin. This compound reacts with aluminium and forms a stable aluminium coumarin-based Schiff base complex. This stable complex was non-toxic to cells.

The coumarin-based Schiff base has high selectivity and sensitivity towards aluminium. Therefore, researchers were able to successfully quantify the levels and activity of aluminium in HeLa cells using real-time live cell imaging. In real-time imaging, the colour change from light yellow to colourless and the appearance of blue fluorescence was visualized with the naked eye. Using this method, aluminium concentrations as low as 1.34 μM could be detected in the intracellular region.

Lens-free imaging easily detects aluminium levels in the intracellular region and in live cells. Thus, it helps diagnose aluminium-induced toxicity. It also helps count red and white blood cells as well as proliferating cancer cells. Moreover, it is low cost.

Spectrochimica Acta Part A, **173**, 537–543.

Fungal Biofactory

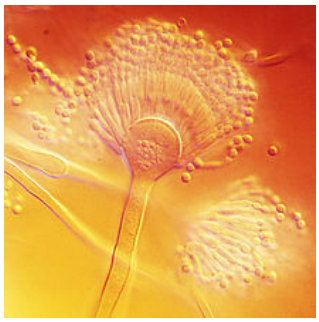
For quantum dot synthesis

Heavy metal pollution is a serious environmental problem. Fungi are known to tolerate and detoxify metals. Jaya Mary Jacob and team at the NIT, Karnataka, now find that, while removing lead from the environment, fungi can also synthesize lead selenide quantum dots (PbSe QDs).

The team used a marine fungus, *Aspergillus terreus*, to study the mechanisms of metal detoxification. This fungus expresses a pathway for PbSe QD biosynthesis. This biosynthesis was confirmed using UV–Vis fluorescence spectroscopy.

The researchers also observed an increase in the total protein content. Results show higher levels of metallothionein in samples after the biogenesis reaction. This affirms the active role of these metal binding proteins in PbSe QD synthesis.

The scanning electron micrographs of the fungal biomass before and after biosynthesis of PbSe QDs showed characteristic surface roughness and agglomerations. The scientists found that the secreted proteins play a vital role in the extracellular co-precipitation of metals.



The fungus releases phytochelatins, metallothioneins and superoxide dismutases, whose function is to scavenge Reactive Oxygen Species. These results suggest that oxidative stress plays a major role in *A. terreus* for the synthesis of PbSe QDs.

This study clarifies the cellular mechanisms involved in the detoxification of toxic heavy metals by the fungus, *A. terreus*. Moreover, it provides an economical and eco-friendly technique for QD synthesis.

J. Hazardous Materials, **324**, 54–61

Ground Support for Titanium

Molding metal–clay catalysts

Titanium oxide is used as a catalyst for the photodegradation of harmful

organic chemicals. But it has small surface area and, therefore, low adsorption capacity for organic compounds. It is also difficult to recover from solutions. This impedes its use in industries. Now, Basu and team, from the Thapar University, Patiala, use clay – an age old water purifier – to boost the activity of titanium oxide nanoparticles.

To improve titanium oxide function, the scientists created titanium oxide–clay nanocomposites. Clay has high porosity and can adsorb a wide variety of pollutants. The scientists worked with three types of clay: Bentonite, Kunipia-F and Kaolin clay. A suspension of clay nanoparticles was mixed with titanium oxide and stirred in a microwave to form titanium oxide–clay nanocomposites. These were then washed, characterized and studied for photocatalytic action.

The researchers found that Bentonite and Kunipia, rich in silica, form composites that are smaller in size and exhibit higher light absorption intensity. The action of titanium oxide–clay nanocomposites was then compared with Degussa P25 – a commercial titanium oxide photocatalyst – for the ability to degrade methylene blue and chlorobenzene in water.

Results show that titanium oxide–clay nanocomposites are better at cleaving organic pollutants. However, titanium oxide–bentonite nanocomposites were found to be five times more efficient in degrading methylene blue, and eight times as effective as Degussa P25 in cleaving chlorobenzene.

Given their superior action, easy preparation and high recovery, scientists are confident that bentonite-titanium–oxide nanocomposites will find wide scale use in industry.

J. Alloys and Compounds, **694**, 574–580

Titanium in Solar Cells

Better way to deposit

Dye-sensitized solar cells mimic plants. Like chlorophyll in green leaves, the organic dyes of these solar cells absorb light. This generates photoexcited charges. There is a coat of titanium dioxide nanoparticles on the surface of these cells. The titanium dioxide separates these photoexcited charges and passes them to suitable materials, generating voltage.

Titanium dioxide nanocrystals, thus, play an important role in dye sensitized solar cells. Depositing a thin film of titanium dioxide nanocrystals over solar cells is, therefore, a critical step. Creating a defect-free crystalline film is tricky. Gaikwad and team, from the Shivaji University, Kolhapur, have now come up with a better method for depositing titanium oxide.

They used a series of adsorptions and ionic reactions to deposit the TiO_2 film over the glass substrate. First, a layer of titanium–water complex is formed which is washed with double distilled water. This removes the loosely bound particles. Then the substrate is treated in a basic medium which forms stable TiO_2 on the surface. Finally the substrate is rinsed again to remove loose TiO_2 particles.

The team reports that this method of deposition improves the crystallinity and electronic nature of the TiO_2 layer. The layer is homogeneous and has fewer defects. This leads to restricted recombination which improves the current density. The best part: the method is cheap and works for large area deposition.

The recipe to print solar cells with the highest efficiency is not complete. Scientists continue to tweak to increase the conversion, even if by mere decimals. Each tweak takes us one step closer to utilizing solar energy to its fullest.

J. Colloid and Interface Sci., **488**, 269–276

Reports by: **Tresa Hamalton, A. C. Surya Prabha, Manish Kumar Tekam, Pavithra P. Nayak, H. M. Mahadevaswamy, P. K. Udham, V. Subashini, G. Sharath Chandra** and **Sarah Iqbal**

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Science Last Fortnight

One-Step Forward

Meteorological forecasting

Much of the uncertainty in weather forecasts is because models miss out on local feedback. Though this feedback is small, it affects mesoscale circulation in the region. Local flows, such as slope winds, impact the atmospheric flow. These local flows are sensitive to radiative changes. This, in turn, influences the boundary layer and regulates the convective system.

Now scientists from the Indira Gandhi Centre for Atomic Research, Kalpakkam, report a study using a numerical model which factors in these local parameters. The team reconstructed the small scale atmospheric conditions of Gadanki, Andhra Pradesh, and examined topographic flows for monsoon and winter 2011.

They used a modelling system that accounts for the influences of local topographic effects. The model showed stronger slope winds in winter and weaker ones in monsoon. And higher prevalence of slope winds at night.

The researchers compared their results with instrumental observations such as the ultra-high frequency wind profiler. The results from the model match simulations from other models. However, since they studied local factors, their results are more detailed.

This high-resolution forecasting system can accurately predict boundary layer features. Since wind systems play an important role in transporting and diffusing pollutants, this model can be useful to forecast air quality over a region.

This high-resolution model can forecast weather down to city level. A small step, but one that makes weather forecasts more reliable and relevant.

Atmos. Res., **185**, 101–117

Aerosol Carbon

Seasonal variations impact health

Air may look immaterial but every breath you take includes tiny solid particles and droplets! These specks of matter, aerosols, have major impacts on climate and health.

Aerosols are complex mixtures of carbon, sulphates, nitrates and minerals. When aerosols increase in the atmosphere, solar radiation reaching the surface and, consequently, crop yield also reduces. Aerosols also lead to persistent haze and fog events, and impact weather patterns and health.

Scientists from the VSSC, ISRO, Thiruvananthapuram, and from the Deen Dayal Upadhyaya Gorakhpur University collected *in situ* aerosol light absorption data from August 2013 to July 2015. They quantified the mass of absorbing aerosols and their potential sources in the Indo-Gangetic plain.

Spectral absorption analysis reveals a four-fold enhancement in absorption at UV wavelengths in winter and post-monsoon seasons. This indicates a proliferation of brown carbon from biomass combustion. During other seasons, spectral absorption at UV is relatively weak, indicating a higher black carbon level in the atmosphere, contributed by industrial combustion. Thus seasonal variation in absorption patterns suggests a shift in fossil fuel to biomass burning at different times of the year.

Wind conditions and the scavenging effect of monsoon rains also influence local seasonal aerosol concentrations.

Long-term measurements of aerosol physicochemical and radiative properties will enhance our understanding of the complex aerosol system over the Indo-Gangetic plain and its climatic implications. The recent Winter Fog Experiment of the Ministry of Earth Sciences will help us predict the effect of aerosols on climate and air quality. This would also be useful to make informed decisions on how best to respond to changing aerosol concentrations.

Atmos. Res., **185**, 13–21

Stable Oil for Deep Frying

Deep frying is a popular method of cooking. It makes food tasty! However, frying changes the oil. It can make it harmful. Oxidative and hydrolytic deterioration takes place. Toxic compounds are generated and accumulate in fried foods. This affects their nutritional quality and shelf life.

Rohit and team from IIT Kharagpur, took a chemometric approach to develop a sunflower oil blend which is stable when heated. Sunflower oil is a healthy choice as it has balanced amounts of saturated and mono-unsaturated fatty acids.

The scientists mixed fresh lots of sunflower oil with oleoresin and ascorbyl palmitate in different combinations.

Potato was deep fried in 18 litres of oil. At the end of each day, the oil samples were cooled down to room temperature and covered. The increase in the contents of total polar compounds and polymeric compounds was proportional to frying time.

The researchers checked the frying stability of sunflower oil blends with different levels of oleoresin and ascorbyl palmitate. The chemometric analysis approach gave consistent and reproducible results. About 1300 mg/kg of rosemary oleoresin and 130 mg/kg of ascorbyl palmitate gave the best results. Potato deep fried in the sunflower oil formulation was stable.

Even though the study used sunflower oil, the approach may be applied to develop other edible oils that are stable during deep frying.

Food Chem., **218**, 496–504

Bacterial Products as Food Additive

Microbial exopolysaccharides have applications in the food and pharmaceutical industries. Technologies for microbial production are well developed and, therefore, commercially viable. Studies increasingly focus on bioprospecting new exopolysaccharides and applications. However, we still lack detailed understanding of existing and commercially established exopolysaccharides.

Andhare and Pathak from the P.D. Patel Institute of Applied Sciences, Gujarat, along with researchers from France, isolated an exopolysaccharide producing bacterium, *Rhizobium radiobacter* CAS, from curd. NMR and FT-IR of the exopolysaccharide from

R. radiobacter revealed that it is succinoglycan.

Succinoglycan is already commercially valuable and marketed under various trade names. It is used to thicken, gel, stabilize and emulsify. Its rheological behaviour, therefore, becomes significant for industry. Hence, the researchers investigated the rheological properties of the extracted exopolysaccharide in aqueous solution.

The viscosity of the solution is proportional to exopolysaccharide concentration. An inoculum concentration of 6% was best for producing viscous exopolysaccharide. The product extracted from *Rhizobium radiobacter* CAS showed better viscosity than other commercially available products.

The extracted exopolysaccharide displays pseudoplastic behaviour, typical shear thinning nature and can resist several thermal cycles, temperatures, pH ranges and electrolytes at wide ranges of concentrations. This makes it attractive to food industries.

Rhizobium radiobacter CAS grows fast even in a minimal medium. It is an efficient microbial cell factory for succinoglycan synthesis. The researchers are confident that it will find immediate application in food, cosmetic and pharmaceutical industries.

Food Hydrocolloids, **64**, 1–8

Quality of Barley Flour

Lowered by bioactive compounds

Nearly 1.75 million tonnes of barley is cultivated in India. However, in comparison to wheat, barley has found limited use as food in India. The presence of bioactive compounds and non-starchy polysaccharides should, in principle, make barley attractive to consumers. But unlike wheat flour, which lends itself to the preparation of a variety of culinary delicacies, barley flour finds very few takers.

Last fortnight, Jeessy Moja and Hardeep Singh Gujral, from the Department of Science and Technology, Guru Nanak Dev University, Amritsar, reported a clue to solve the problem. They subjected hulless barley cultivars to roller milling and found that this results in less than 50% of refined flour. This may be due to the influence of non-starch polysaccharides on barley milling behaviour.

They evaluated the bioactive compounds of milled fractions. β-glucan, which plays a vital role in diabetes and cholesterol control, is one of the major attractions of barley. But the presence of greater levels of β-glucan in whole barley flour and bran of high altitude cultivars affected the refined flour inversely.

Cultivars with higher β-glucan and arabinoxylan content displayed greater levels of starch damage during the roller milling process. Higher levels of non-starchy polysaccharides affected the flour yield negatively leading to low flour extraction rates.

β-glucan is distributed throughout the aleurone and endosperm rather than being confined to outer bran. However, non-starchy polysaccharides, anthocyanin and total phenolic contents are higher in the bran fraction. So, removing bran before milling improves the flour yield. But at the same time, it reduces the nutraceutical value of barley.

The scientists found that treatments prior to milling also affect the outcome. Amongst all treatments, conditioning grains to a moisture content of 14% for 30 minutes was found to be the best to improve the flour output from milling.

Food Chem., **218**, 137–143

Safer Renal Transplants

Enterocytozoon bieneusi

Kidney transplantation is the treatment of choice for end-stage renal disease. But infection after transplantation is a major risk. The immunosuppressive therapy carried out among kidney recipients makes them more susceptible to infection. *Enterocytozoon bieneusi* is the most common microsporidia, causing intestinal infection in renal transplant recipients.

Spores of *E. bieneusi* have been detected among animals, birds and humans worldwide. However, the transmission route of *E. bieneusi* among renal transplant recipients in India is still a puzzle.

Sonali and team, from the Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, examined *E. bieneusi* genotypes among renal transplant recipients in India. They analysed the genetic diversity of *E. bieneusi* and inferred the phylogenetic relationships and the transmission of different genotypes among infected hosts.

The scientists examined stool samples of RT recipients infected with microsporidia for species identification. Using internal transcribed spacer sequencing, they identified eight genotypes, including four new genotypes.

Then they analysed the phylogeny of genotypes and revealed that genotypes Ind1, Ind5 and Ind6 were clustered with zoonotic genotypes D and L. These genotypes could, thus, have been transmitted from animals to humans. This supports the potential of the zoonotic route of *E. bieneusi*.

Genotypes Ind2, Ind3, Ind4, Ind7 and Ind8 showed close sequence similarity to genotypes reported exclusively from humans. Therefore, these genotypes could have been transmitted via the anthroponotic route.

The study throws light on the zoonotic as well as the anthroponotic transmission of *E. bieneusi* among renal transplant recipients through the faecal-oral route. Extreme hygiene may, perhaps, be one method to avoid infection with *E. bieneusi.*

Acta Parasitol., **62**(1), 63–68

In Times of Epidemics

Vaccine + treatment = cost reduction

Ebola, dengue, chikungunya, encephalitis... Epidemics elicit fear. Diseases bring pain, dysfunction and loss, both personal and financial.

There are two strategies to tackle epidemics: vaccination and treatment. Which is better? Anuj Kumar and Prashant K. Srivastava, at the IIT Patna, used a mathematical model, SVIR – Susceptible, Vaccinated, Infected, Resistant – to compare these strategies, alone and in combination.

Using numerical simulations, the researchers tested the impact of each strategy on disease dynamics and associated costs: cost due to disease, cost involved in vaccination as well as cost of treatment and related efforts.

The strategy of combining both vaccination and treatment was most cost effective in lowering disease prevalence during epidemics. It also helps monitor the infective population.

Commun. Nonlinear Sci. Numer. Simulat. **44**, 334–343

Healing with Fish Skin

Collagen for wound healing

Although collagen-based wound dressings have been around for a while, they do have a few drawbacks. Commercially available collagen is mostly derived from terrestrial animals, making it susceptible to prion infections. Moreover, collagen, being proteinaceous in nature, is host to a wide variety of microbial infections.

Recently, scientists at the CSIR-Central Leather Research Institute, Chennai, isolated collagen from starry puffer, a marine fish.

Collagen was homogenized and freeze dried to prepare a collagen 'sponge'. It was then impregnated with ivy gourd extract. Ivy gourd is known to possess antioxidant and antibacterial properties. This combats microbial infections.

The researchers then examined the physiochemical and biological properties of this spongy material. They tested its biocompatibility by allowing keratinocytes and fibroblast cells to grow on it. The spongy material was found to promote cell–cell adhesion and also increased cell viability.

In vivo studies show that the spongy material could accelerate healing by increasing the expression of growth factors responsible for the synthesis of collagen. The dressing substrate was also found to possess requisite mechanical properties. The researchers are optimistic that their work can prove to be the future of collagen-based wound management.

Mat. Sci. Engg C, **72**, 359–370

Genetic Diversity = Host Specificity

The case of Trypanosoma evansi

Trypanosoma evansi is a widespread pathogen. It causes a disease, *surra*, transmitted by insect bites.

Trypanosomes use a transferrin receptor to uptake host iron biomolecules for growth and multiplication. The typical symptoms are fever, anaemia, loss of appetite and weight loss. *T. evansi* infection is responsible for morbidity and mortality in animals around the world and is included in the list of noticeable diseases by the World Organization for Animal Health.

Scientists from the ICAR-National Research Centre on Equines and the Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, examined genetic diversity among *T. evansi* isolates from the Indian subcontinent. The researchers collected *T. evansi* from infected camel, cattle, donkeys and ponies in Haryana, Gujarat, Rajasthan and Uttar Pradesh.

The team observed a variation of about 17% in the nucleotide sequence of the transferrin receptor-encoding region. And up to 31% variation in the amino acid sequence. Analysis of the Indian variants of the region and their respective clade position presented a host-specific distribution. This indicates homogenous parasite population in each animal host species.

Such studies are useful in sub-typing *T. evansi* isolates in India and also for understanding the virulence pattern of the subtypes. Moreover, the sequencing data from Indian isolates might find applications in designing primers for diagnostics.

Acta Parasitol., **62**(1), 133–140

Disability in the Elderly

Functional disability is an emerging concern as the world greys. The inability to carry out daily activities normally affects the quality of life of the elderly. Disability studies indicate that India has the highest prevalence of functional disability among older adults in Asia.

To understand the possible predictors of functional decline among older adults, Arti and Yashoda, from the Pune University, conducted a study in 2011–12 and 2013–14. The study covered 1140 adults, aged 60 and above. The researchers administered a functional ability assessment tool, designed for the purpose, to capture changes in the ability to perform daily living tasks. The tool assessed lifting, walking, climbing, arising from bed/chair, toilet use, dressing, self-cleaning, eating, squatting, bending, etc.

The respondents were classified into two groups, based on a four-point scale. Simple frequencies and chi-square tests were used to identify the significance of associated factors. The scientists also used binary logistic regression models to extract factors that can explain increased disability.

A follow-up survey showed an increased level of chronic illness from the baseline.

Hospitalization, irrespective of cause and duration, was identified as a major factor for predicting functional disability. The association between disability and chronic illnesses is well established.

Interestingly, there was greater functional decline among females. This may not be just due to biological disposition. Other social factors need to be taken into account to explain this gender disparity.

The results of the research indicate absence of adequate supportive services after hospitalization. The scientists recommend the introduction of affordable transition care services to reduce functional disabilities in older adults.

Arch. Geront. Geriatr., **69**, 151–155

Sugar Spent Wash

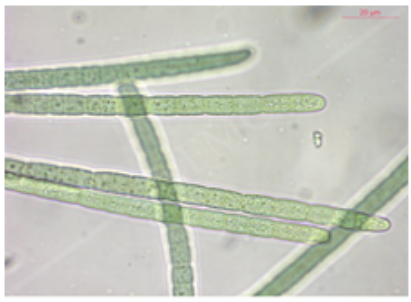
Low-cost cleaning technique

High pollution load makes spent wash from cane distilleries a threat to the environment. Physical, chemical and biological methods have been tried for treating spent wash. However, melanoidin, a coloured pigment found in spent wash, is, for example, not easy to remove.

Last fortnight, Dhanapal and Subramanian, from the Bannari Amman Institute of Technology, Tamil Nadu, reported devising a cost-effective biophysicochemical method for the removal of colour and other pollutants. They pre-treated the spent wash using sand filtration. To purify it further, they passed it through a modified chitosan hydrogel grafted banana pseudo stem, which they synthesized for the purpose.

The team then used marine cyanobacteria, *Oscillatoria boryana*, for decolourization and to reduce chemical oxygen demand. Then they removed the final traces of pollutants by electrolysis.

Scanning electron microscopy of the modified chitosan hydrogel showed a bulk distribution of pores that allows maximum adsorption of trace impurities. The researchers achieved a colour reduction of 97.2% in the visible spectrometry. They reported a net reduction of >99% in chemical and biochemical oxygen demand values.



They also studied the adsorption isotherm and kinetics of the adsorbates and found a maximum adsorption on activated carbon and modified chitosan hydrogel banana pseudo stem.

The researchers claim that the treatment costs only 150 INR/m^3 of spent wash to achieve a final COD of <100 ppm. They are confident that the low-cost and eco-friendly method will provide a solution for the safe disposal of spent wash.

J. Appl. Pol. Sci., **134**(9), 44546

Rising Industrial Mercury
Polymer for efficient removal

Mercury is a heavy metal which finds use in many industries. However, its disposal is tricky and a small fraction of the metal may leach and contaminate water bodies leading to severe health problems. Presently, there are many methods to remove mercury from water. But these are expensive and require sophisticated instruments. Recently, Tripathi and team, from the Midnapore College, West Bengal, fashioned Katira gum conjugates that can remove mercury ions from water more economically.

Poly N-vinylimidazole or PNVI hydrogels can complex with metal ions. However, they are insoluble in water and cannot function over a wide pH range. To remedy this, the scientists grafted the PNVI hydrogels to Katira gum – a natural polysaccharide. Next, these gum–hydrogel conjugates were precipitated, washed and complexed with sulphate ions to boost solubility and selectivity for mercury ions. The scientists then assessed the performance of the sulphated conjugates on mercury ion retrieval at different conditions of pH, temperature and ion concentration.

Electron microscopy shows that each step of chemical modification introduces new structural features in the Katira gum conjugates making them more soluble. The finished sulphate gum–hydrogel conjugates are soluble even in cold water. The conjugates are highly specific for mercury and show maximum activity at 40 degrees and pH 5.0. They take only about 2 hours for removing mercury ions to maximum potential, after which they can be regenerated by treatment with an alkali.

The conjugate can be used for up to three cycles before it loses 30% of its efficiency. Given the nature of synthesis and the low cost of the substrates, the scientists are confident that their polymer conjugate has potential to be developed as a low cost tool to remove mercury from water.

J. Appl. Polym. Sci., **134**(10), 44565

Reports by: **G. Manoj Praveen, Manish Kumar Tekam, A. C. Surya Prabha, Anubhab Dey, S. Malarvannan, Prashant K. Parida, G. Anuradha, H. M. Mahadevaswamy, Sanghamitra Deobhanj, Shumaila Afrin, P. Vijisha, Tresa Hamalton** and **Sarah Iqbal.**

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Science Last Fortnight

Oxytetracycline in Milk

Detection made easy

Antibiotics are widely used in livestock management practices to safeguard the health of the animals. In dairy husbandry, milk producers rely on antibiotics to treat mastitis and other infectious diseases. It is natural that these antibiotics find their way into milk. Some antibiotics, such as tetracycline derivatives, are contraindicated for pregnant women and children, the largest consumers of milk.

Laxmana Naik and team, from the ICAR National Dairy Research Institute, recently developed a rapid, semi-quantitative lateral flow assay to screen oxytetracycline residue in milk samples. The scientists generated and purified polyclonal antibodies against the oxytetracycline molecule. They used colloidal gold nanoparticles as labelling material by conjugating it with the antibody. Oxytetracycline coupled with carrier protein was placed on a test line. Species-specific secondary antibodies were placed on the control line of the membrane matrix. The assay was validated by adding known quantities of oxytetracycline to antibiotic free milk samples.

The results could be seen within five minutes without any equipment. The visual detection limit was 30 parts per billion!

This type of rapid and sensitive visual screening assay has practical applicability. Using such lateral flow assay strips, milk can be tested for oxytetracycline at collection point. For consumer safety, the dairy industry can now take steps to monitor antibiotic residue in milk.

Food Chemistry, **219**, 85–92

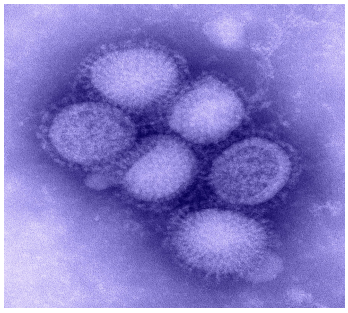
Complementing the Immune System

2009 influenza pandemic

Immunology never got the boost it deserves as the neurosciences did with the Decade of the Brain in the 90s. However, the discipline seems to be maturing without much international attention.

Last fortnight, scientists from two Pune based institutes, the NCCS and the NIV, delineated further details in the web of interconnectedness that constitutes the immune system.

Besides the cellular components of the innate and adaptive immune systems, there is the complement system with a more diffused existence which yet exerts control. The scientists in Pune focused on this component in the context of the pandemic influenza virus A(H1N1) that swept through India in 2009.



Through a series of experiments using mice, *in vitro* petri dish studies and clinical data, they bring out the interplay of the classical as well as alternative complement pathways to neutralize the virus.

Usually, antibodies against H1N1 hemagglutinins start appearing on the fifth day and the viral load decreases from the seventh day of infection. But, where the complement system does not work, weight loss and mortality ensue.

Using experiments with mice lacking one or other aspect of the complement system, scientists showed that, in cases of deficiencies in the complement C3, IgM production was significantly reduced; clearance from lungs does not take place; mortality is highly predictable.

Interestingly, they also found that, though complement C3 is primarily produced in the liver, it is C3 from B cells in the spleen that produce the effect.

Using *in vitro* studies, the scientists showed that antibody-coated viruses are effectively neutralized by the complement. The classical pathway of the immune system deposits C3b onto the viral surface. This activates the alternative pathway loop. 'Unlike the pandemic influenza virus, seasonal influenza virus A(H3N2) is neutralized by the alternative pathway. The difference is in the ability of their surfaces to allow C3b deposition. C3b deposition was efficient on the A(H3N2) viral surface, but not on the A(H1N1) virus unless coated by antibodies', they say.

Besides providing insights into basic immunology, the research has applications. It also shows that immune sera, from the mice without complement system deficiencies, can prevent mortality. Moreover, in humans, IgG1 antibodies in the sera of infected-positive individuals are capable of supporting the neutralization. So if you have deficiencies in your complement system, and are infected with such a virus, supplement the treatment with the right antibodies.

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Probing Memory Loss

Biosensors for acetylcholine

A reduced level of acetylcholine in the brain is implicated in neural disorders such as Alzheimer's and Parkinson's diseases. In order to understand the functional and physiological aspects of neural disorders caused by changes in acetylcholine concentration, a sensitive, rapid and accurate detection tool is required. Though several electrochemical biosensors are available for acetylcholine detection, high cost, limited availability, and inaccurate detection deter the use of these sensors in clinical practice.

Nidhi Chauhan and team, from the Amity University, Noida, have now fabricated a low-cost technique: an enzyme-based chemical sensor to convert acetylcholine into a reporter molecule that can be recognized by an electrode. They used a conducting polymer to modify a fluorine-doped tin oxide electrode. This helps in fast electron transfer. Addition of reduced graphene improved the conducting properties of the electrode. They used iron oxide nanoparticles on this composite for the electro-catalytic oxidation of acetylcholine.

The team estimated the acetylcholine content in serum samples and found negligible interference of ascorbic acid which is a major interferent in earlier reported biosensors.

The newly developed sensor claims a very low detection limit. The sensor remained active even after storage for a hundred days. Moreover, this new sensor can be used multiple times.

The researchers claim that the cost of producing the biosensor is lower than that of existing sensors. They are confident that high sensitivity, reusability and low-cost will help translate their lab results into an industrial product for the clinical diagnosis of neural disorders.

Biosensors and Bioelectronics, **89**, 305–311

Encapsulating Fish Oil

Sage extract is safer

Omega-3 fatty acids offer many health benefits. These fish oil supplements are available as capsules. But the product goes through slow oxidation. To reduce oxidative degradation, microencapsulation of fish oil is a useful technique.

Spray-drying is one of the cheapest methods for microencapsulation. However, the mechanical shearing involved in atomization destabilizes and collapses the capsule during drying. The stability of the capsules can be improved by using protein cross-linking agents such as formaldehyde, glutaraldehyde and transglutaminase. But these chemicals cause adverse health and environmental effects.

Last fortnight, Binsi and team, from the ICAR-Central Institute of Fisheries Technology, Cochin, identified plant essential oils rich in antioxidants as natural cross-linkers. The emulsions were prepared with sodium caseinate as polymer, gum arabic from *Acacia senegal* as co-polymer and sage extract as wall stabilizer.

The researchers encapsulated two different emulsion formulations: fish oil emulsion and fish oil containing 1% sage extract. Using accelerated storage, they examined emulsion stability, microstructure, encapsulation efficiency, percentage loss of oil and the morphological and physical properties of the microencapsulates, as well as oil release properties and lipid oxidation.

Incorporating sage extract improved the surface morphology and size uniformity of the encapsulates. The sage extract, at 1% level in the emulsion, prior to spray drying, increased encapsulation efficiency and lowered surface oil content.

Sage extract offered significant protection against fat oxidation and improved shelf life. When stabilized with gum arabic and sage extracts, fish oil capsules exhibit higher encapsulation efficiency than encapsulates with gum arabic alone. So, the scientists recommend the incorporation of sage extract in fish oil before spray drying.

Food Chemistry, **219**, 158–168

Gelled Within

Seaweed extract for drug delivery

Curcumin, an active ingredient in turmeric, has remarkable anticancer properties. But poor solubility in water limits its use as cancer therapeutic. Scientists are now looking at different drug delivery agents to boost curcumin's performance within living systems by ensuring sustained drug release.

Balaram Madhan and team, from the CSIR-Central Leather Research Institute, Chennai, now find that a polysaccharide isolated from red seaweed may serve as ideal drug delivery agent for curcumin. The bulk of the polysaccharide content in red seaweed is made up of kappa-carrageenan with excellent gelation properties. The scientists synthesized kappa carrageenan beads through the solvent evaporation method and loaded them with curcumin. They then tested the beads for drug entrapment, drug release, and cytocompatibility in living cells.

The studies show that there was effective interaction between the polymer and the drug in the bead matrix. The researchers also found that drug release from the beads was pH dependent. Approximately twice the amount of drug was released from carrageenan beads at an acidic pH as compared to the physiological pH. Since tumour microenvironment is usually acidic, this finding presents interesting drug targeting opportunities.

The antitumor properties of the carrageenan–curcumin beads were also explored in lung cancer cells. The drug–polymer complex could induce apoptosis, or programmed cell death in cancer cells. The scientists found that carrageenan could boost the anticancer action of curcumin. Cytocompatibility, ease of use and gelling properties make kappa carrageenan an ideal drug delivery agent for curcumin and other drugs that suffer from reduced bioavailability within living systems.

Carbohydrate Polymers, **160**, 184–193

Design Meets Function

Liposomes for targeted drug delivery

Targeted delivery of drugs to tumour cells is a prerequisite for treating cancer. But, because most drug carriers unload the therapeutics in the vicinity of the tumour, and not within the cell itself, the efficiency of treatment is reduced. Recently, Rashid Madhuri and team from the Indian Institute of Technology, Jharkhand, synthesized nanosized drug carriers that can ensure drug targeting to the cancer cell nucleus.

Liposomes have long been used as efficient drug delivery candidates due to their stability and nontoxic nature. To improve target specificity and cell penetration, researchers added two components to the liposomes: carbon dots to trigger drug release and TAT – a cell penetration peptide to enhance cell permeation. In order to reduce the cost of this process, the liposome itself was prepared from precursors derived from inexpensive laboratory chemicals.

Once synthesized, the liposomes were hydrated using either a phosphate buffer or ammonium bicarbonate. The liposomes were loaded with an anticancer drug, doxorubicin, and assessed for therapeutic efficiency in terms of drug entrapment, drug release, cell compatibility and toxicity.

The scientists found that liposome hydration, in the presence of ammonium carbonate, introduces a bubble within the liposome that increases its drug entrapment efficiency. The cytotoxicity and drug unloading capacity of both normal and bubble containing liposomes were studied in breast cancer cells. Results show that both liposomes

are equally compatible with cell systems and can easily penetrate cancer cells.

Once inside the cell, the drug is released when triggered by near infrared radiation. The targeted near infrared radiation raises the temperature of the afflicted tissue by a few degrees above normal body temperature. This activates the carbon dots, triggering a burst of drug release from both sets of liposomes with bubble liposomes exhibiting a more rapid response. Such activity is not present in liposomes lacking carbon dots, demonstrating the effectiveness of the vehicle architecture.

Due to the presence of carbon dots, these liposomes can also produce bright fluorescence when illuminated with different lasers. This allows scientists to track drug delivery within the cells in real time.

Given the multiple advantages associated with carbon dot–TAT associated liposomes, scientists are confident of their potential for efficient cancer drug delivery.

Chemical Engineering Journal, **312**, 144–157

Deciphering *Bungarus*' Codons

Fine-tuning gene expression

A codon is a series of three nucleotides and codes for a specific amino acid residue in a polypeptide chain. Or for the termination of translation – stop codons. The permutations of three letter words, from four possible nucleotides, give 64 unique combinations. But there are only about 20 amino acids. So there is some amount of redundancy in the code and there are synonymous codes for the same amino acid. However, a particular species may exhibit partiality towards a specific codon. Codon bias can help understand the dynamics of gene expression and evolutionary relationships.

A team led by Supriyo Chakraborty from the Assam University, in collaboration with the Moinul Hoque Choudhury Memorial Science College, Assam, compared codon patterns among four species of the genus *Bungarus*: the many-banded krait, banded krait, blue krait and red headed krait. The *Bungarus* genus, distributed across South and Southeast Asia, has some of the most poisonous land snakes in the world. The team analysed genes available in public databases to understand evolutionary patterns.

All species showed a similar pattern in nucleotide composition. This indicates that they share similarity in structure and biological function.

The highest mean value of adenosine was observed in all the species except in *B. fasciatus* which had the highest mean value of cytosine. This indicates that compositional constraint under mutation pressure has affected codon usage in different species of *Bungarus*.

The effective number of codon values in the four species ranged from 35 to 60, indicating the existence of almost all synonymous codons for an amino acid in *Bungarus*. The effective number of codons has an inverse relationship with codon bias. And this reflects greater genetic variability. High genetic variability widens the platform for evolution by mutation pressure and natural selection.

Both natural selection and mutation pressure affect codon usage pattern. Natural selection was greater in *B. fasciatus*, *B. multicinctus* and *B. candidus*. But less in *B. flaviceps* in which mutation pressure was higher compared to that in other species. This suggests that, in *B. flaviceps*, three headed krait, the rate of evolution has been faster compared to that in the other three species.

Codon bias is a unique property of the genome of an organism. It is species-specific and may vary among the genes within the same organism. Natural selection plays a major role while mutation pressure has a minor role in the codon usage pattern of the genes in the *Bungarus* species. The scientists have thus improved our understanding of the molecular biology and evolution of the *Bungarus* species.

Gene, **604**, 48–60

Quantum-cells for Solar-energy

Efficient energy production

Fossil fuels are limited. And their use damages the environment. To meet growing energy needs, sunlight, a major renewable source, is an alternative. However, current technologies to harvest solar energy are not very efficient.

Researchers from the Sri Venkateswara University, Tirupati, collaborated with foreign universities to develop a quantum dot nanomaterial for the more efficient harvesting of solar energy. The nanomaterial was doped with ytterbium and zirconium oxides. These rare earth elements enhanced the photo-conversion efficiency of quantum dot solar cells.

Quantum dot solar cells, doped with rare earth elements, block the leakage of photogenerated electrons from the electrode. This suppresses charge recombination effects – the dissociation of an excited electron pair into free collectable charge carriers. So the doped quantum dot solar cells show enhanced photon-to-electron conversion efficiency: more solar energy fixing with fewer photons. In fact, these cells show 55% higher photo conversion efficiency than the currently available solar cells.

Quantum dot solar cells, doped with rare earth elements, are cheaper than other solar cells. The scientists claim that solar panels with such cells can change the economics of renewable energy production.

J. Alloys and Compounds, **698**, 433–441

Sugar Coating Steel

Anti-corrosion effects of Isabgol

Metal–acid interaction is a major cause of steel corrosion that leads to huge economic losses each year. Most industries use synthetic chemical inhibitors that can be coated on metals to reduce corrosion. But these chemicals are expensive and toxic. Now, Mohammad Mobin from the Aligarh Muslim University, suggests the possibility of using a carbohydrate isolated from the Isabgol plant as an effective corrosion inhibitor.

Mobin and his team reasoned that the sugar in the Isabgol plant – arabinosyl rhamnosylxylan – is highly branched and contains several hydroxyl groups which can form stable interactions with iron. Because the molecule is large it may offer enhanced protection by coating the metal to a greater extent. To test this hypothesis, the scientists isolated Isabgol mucilage

by soaking it in water. Next, they isolated arabinosyl rhamnosylxylan from the solution which was then tested for anti-corrosion properties in an acidic solution.

The researchers applied increasing concentrations of Isabgol carbohydrate extract to washed low carbon steel coupons in an acidic environment. Uncoated coupons exhibited greater metal loss and showed more signs of damage as opposed to steel coupons coated with arabinosyl rhamnosylxylan. Metal–carbohydrate interaction studies reveal that this is due to the formation of stable metal–arabinosyl rhamnosylxylan interactions at the interface, strengthening anticorrosion properties.

Given that the source is natural, inexpensive and readily available, scientists are confident that arabinosyl rhamnosylxylan could be developed into a nontoxic, anticorrosive material for industrial applications.

Carbohydrate Polymer, **160**, 172–183

OLED in the Lead

Improved light extraction

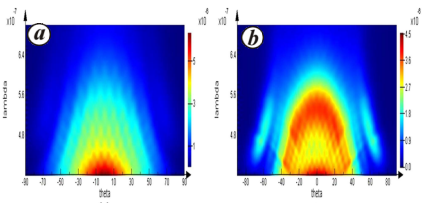
OLED – Organic light-emitting diode – is fast replacing LED LCD technology. High-end smartphones, digital cameras, tablets, laptops, and television sets use OLED.

In LED LCD display screens, pixels are illuminated using a back-light. In OLED, however, pixels produce their own light. Better brightness, contrast, viewing angle, colour distinction and range, as well as quicker refresh rates are other advantages. Moreover, OLED screens are ultra-slim, stretchable and transparent.

These diodes consist of two organic layers, embedded between two electrodes. One emits and transports electrons while the other transports holes. The electrode above is a metallic mirror with high reflectivity. The bottom electrode, a transparent anode layer, is on top of a glass substrate.

Vidhi Mann and Vipul Rastogi, from IIT Roorkee, recently used dielectric nanoparticles to improve the light extraction efficiency of OLED. Indium tin oxide acted as anode on top of the glass substrate. Aluminium was used as cathode. An organic layer of N,N′-di(naphthalene-1-yl)-N,N′-diphenyl-benzidine acted as hole transport layer. Another, tris(8-quinolinolato) aluminium (Alq3), as emissive layer. There was also a lithium fluoride electron transport layer.

The researchers used the Finite Difference Time Domain method and Mie Theory to analyse the effects of these dielectric nanoparticles. The nanoparticles were assumed to be spherical and optically lossless. Parameters such as diameter, inter-particle separation and the refractive index of the nanoparticles were optimized to improve light extraction efficiency.



A comparison of far field intensity distribution for (***a***) conventional OLED and (***b***) OLED with nanoparticles.

Nanoparticles, in OLEDs, scatter light. The researchers found that this phenomenon depends on index contrast. Simulation showed that light extraction efficiency did not increase with larger diameter nanoparticles because of the decrease in the number of scattering sources. Maximum enhancement, approximately 1.7 times, is seen with nanoparticles of 100 nm diameter, with no inter-particle spacing and a refractive index of 1.1, at around 500 nm wavelength.

Dielectric materials, such as mesoporous silica, aluminium oxide and zirconia, can be used as nanoparticles in OLEDs. The researchers suggest that the use of appropriate dielectric nanoparticles can further boost the amount of light from optical structures. This can be utilized for enhancing user experience of OLED screens.

Optics Communications, **387**, 202–207

Software for Easy Trading

The price of a stock fluctuates. The nonlinear nature of stock price movements makes forecasting difficult. Timing of buy/sell decisions becomes a challenge. This risk keeps many from trading in stocks.

Binoy Nair and team from the Amrita School of Engineering, Coimbatore, recently analysed clustering stock price time series data to generate stock trading recommendations. They considered twenty stocks for evaluating these recommender systems. This helped keep the computation inexpensive. The stocks were chosen to represent markets from four different geographies: BSE from India, NYSE from the USA, LSE and FTSE from the UK and BOVESPA from Brazil. Stocks from aircraft manufacturing, banking, communication, food, petroleum, consumer retail, textile, travels, etc. were considered.

The researchers considered 16 variants of the recommender system. The economic performance of these systems was evaluated on eight different performance measures.

The performance was based on profit generated by the recommender system. The system was trained using a cyclic component. Weekly trading was done using regression tree-based feature selection and sliding window-based adaptive learning. Regression trees are useful for reducing dimensionality and Self-Organizing Maps are used to cluster data.

Taking cyclic components helped the recommender system capture short-term fluctuations in stock prices better. This produced better results than working with the entire dataset. Soft computing-based systems can extract relevant information from large sets of data by discovering hidden patterns.

Historical stock price data can be used to forecast future trends and recommend when to buy/sell stocks. Using such systems, anyone might be tempted to invest in equity markets.

Expert Systems with Applications, **70**, 20–36

Reports by: **Sanghamitra Deobhanj, G. Sharath Chandra, P. K. Udham, G. Manoj Praveen, H. M. Mahadeva Swamy, A. C. Surya Prabha, S. Malarvannan, Prashant Kumar Parida, V. Subashini, Shumaila Afrin** and **Sarah Iqbal**

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Science Last Fortnight

Low-Cost Water Purification
Removing arsenic and fluoride

Arsenic and fluoride in drinking water are a worldwide concern. Exposure to these chemicals poses a threat to health. However, existing techniques to remove them from water involve high costs and yet offer low removal efficiency. Last fortnight, scientists from the Indian Institute of Technology, Roorkee, reported an alternative technique to remove both from water more economically.

The researchers optimized an electrocoagulation reactor for removing arsenic and fluoride in water. They achieved a maximum removal of both in synthetic water at neutral pH. And removal was rapid at a current density of 10 A/m^2, run time of 95 min and inter-electrode distance of 1 cm. Sodium chloride, used as supportive electrolyte, removed 98.51% arsenic and 88.33% fluoride. The metal hydroxides, generated *in situ*, act as coagulant in aqueous solutions, and provide active sites for the adsorption of polluting species.

The scientists evaluated this technique to purify the natural ground water collected from the Rajnandgaon district. And they found that the concentration of arsenic and fluoride could be brought down to below the maximum permissible limit.

The operation cost of the reactor – cost of electrode material and electricity – is only Rs 23 per cubic meter of water, much cheaper than earlier methods. Entrepreneurs, in areas affected by arsenic and fluoride in groundwater, can now mass produce this efficient and low-cost technology.

J. Environ. Management, **190**, 102–112

Nature's Fertilisers
Beneficial bacteria bearers

Prolonged use of fertilisers can lead to the loss of beneficial soil microflora, water pollution and health hazards including increased propensity to stomach and bone disorders and cancers. Consequently, there is a pressing need for environment-friendly substitutes to chemical fertilisers. Rhizobacteria, to promote plant growth by improving nutrient bioavailability, has been suggested for reducing chemical fertiliser use. However, biofertiliser formulations have short-shelf life.

Last fortnight, scientists at the IIT Dhanbad, in collaboration with the Ural Federal University, reported biofertiliser formulations with better shelf life. They used biochar and flyash as carriers for two Rhizobacteria species.

They tested the efficacy and shelf life of formulations based on fly ash and on biochar by assessing soil fertility as well as the growth of tomato plants. Tomato seeds treated with these bioformulations had a significantly higher rate of germination and yielded plants with higher biomass, leaf-length, number and size of flowers and fruits.

In contrast to flyash as carrier, biochar was found to be better suited to ameliorate soil fertility. The bacteria-based fertilisers in biochar increased the shelf life, for as long as 240 days! With improved shelf-life, it can now be marketed as a substitute for chemical fertiliser.

In an agrarian economy like India, it makes sense to use agricultural and industrial waste. It can also be an eco-elegant approach to resolving soil fertility and food productivity problems.

J. Environ. Management, **190**, 20–27

Conservation of Keoladeo
Mathematical models

The Keoladeo National Park is a Ramsar site. These wetlands, the erstwhile duck-shooting reserve of the Maharajas of Bharatpur, were declared a national park in 1982 and a World Heritage Site by the UNESCO in 1985. The park now provides a safe haven for migratory waterfowls and it is the only regular wintering place for the endangered Siberian crane. But how do we assure the stability of this ecosystem?

Last fortnight, Atasi Patra and others from the Birla Institute of Technology and Science, Pilani, Rajasthan, reported a series of three mathematical functional response models to tackle the problem.

The first model is based on the prey–predator model. The researchers considered floating vegetation, fishes, waterfowl and other species useful to birds, as 'good' biomass and wild grasses such as *Paspalum distichum*, *Pseudoraphis spinescens*, and *Hydrilla verticillata*, which deplete the dissolved oxygen level in water bodies as 'bad' biomass. Good biomass acts as prey and bird population as predator. It was seen that, when the growth rate of good biomass is greater than a threshold value, the positive equilibrium is globally stable and the model was found to be ecologically well behaved.

The second model took into consideration the degradation of wetlands due to bad biomass. The first model was extended to study the impact of bad biomass on good biomass, and consequently on bird population. It was found that, if no efforts are made to control the growth of bad biomass in the wetland, good biomass will reduce and, consequently, the survival of bird populations will be threatened.

The third mathematical model was on the management of the wetland park. In this functional response model, the second model was extended to evaluate the outcome of the effort on bad biomass, and, consequently, on good biomass. It was found that, if the density of the effort increases, good biomass increases and bad biomass decreases and, consequently, the density of bird population increases. The scientists showed, theoretically as well as numerically, that, even if the wetland is in bad health, by intervening with suitable effort, the density of bad biomass can be lowered, increasing good biomass and bird population.

Depending on initial conditions, all three models have multiple steady states under different community regions. Development of such models can be useful in making policy decisions for the conservation and management of wetland ecosystems.

Mathematics and Computers in Simulation, **134**, 54–78

Pesticide Residue on Fruit

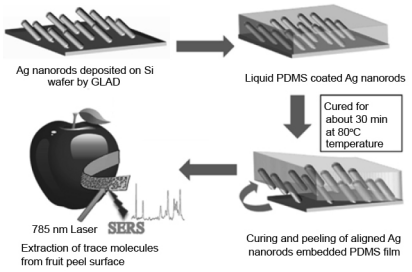
Chemicals on curved surfaces

Pesticides are used in agriculture to increase food security. However, pesticide residue in food raises health concerns. Pesticide residue testing is carried out to ensure compliance with regard to maximum residue levels. Yet it remains challenging for analytical laboratories to detect, identify and quantify many different pesticides.

A research team led by Samar Kumar from IIT, Delhi, developed a simple method for the rapid detection of pesticide residue on the surface of fruit. They used a flexible polymeric material – polydimethylsiloxane – that can conform to the surface of the fruit. Polymethylsiloxane can be examined using Surface-Enhanced Raman Spectroscopy (SERS), a technique which enhances the vibrational spectrum of molecules adsorbed on or in the vicinity of metal particles and/or surfaces. Because of its readiness, sensitivity and least sample preparation requirements, SERS is considered a powerful technique for food inspection.

The researchers embedded silver nanobots (AgNRs) in polydimethylsiloxane. This enhanced portability and mechanical stability. The embedded AgNRs layers showed good adhesion on the polydimethylsiloxane surface as demonstrated by the scotch tape peeling test. These results demonstrate that AgNRs embedded in the flexible substrates are mechanically robust. The team also confirmed that *in situ* SERS signal intensity on flexible substrates under mechanical strain remains almost constant for an induced tensile strain value.

They then tested the AgNRs embedded polydimethylsiloxane substrate. They used a 'paste and peel off' approach to extract pesticide residue from fruits. And checked whether they could detect thiram and chlorpyrifos, commonly used pesticides.



The SERS signals were strong and easily distinguishable. Through enhanced Raman signals on the AgNRs embedded polymer substrate, thiram adsorbed from apple was detected at concentrations as low as 2.4×10^{-9} g/cm^2.

The robustness of the AgNRs arrays based polydimethylsiloxane reveals possibilities for flexible sensors capable of being deployed for onsite, rapid, sensitive, chemical sensing and trace chemical detection on non-planar surfaces.

Sensors and Actuators B: Chemical, **241**, 577–583

Carbon dot-DNA Hybrid Hydrogels

Uniform drug delivery for cancer

Most drug delivery systems involve a burst phase followed by suboptimal levels in blood. Last fortnight, a group of researchers from the Bhabha Atomic Research Centre in collaboration with the Indian Institute of Technology, Patna, and the National Institute of Pharmaceutical Education and Research, have come up with a solution: a carbon dot-DNA hybrid hydrogel to encapsulate the drugs.

Less than 10 nm in size, the carbon dot is a relatively new member of the nanoparticle family and, unlike the case with conventional nano devices, does not face issues of solubility, biocompatibility and biodegradability. DNA is used to create the hydrogel to ensure biodegradability and biocompatibility. The researchers used a DNA sequence rich in cytosine because it has a distinct ability to form an i-motif structure, ideal for hydrogel formation in acidic conditions.

The researchers compared the drug release profile of the hydrogel and found that the drug was released faster in an acidic environment. Thus, DNA's pH sensitivity ensures that the drug is released only in regions with high acidity, a common environment for cancer cells.

They encapsulated doxorubicin, an anticancer drug, in the hydrogel by incubating in an aqueous solution. The drug is attached to hydrogel both by electrostatic interactions as well as through intercalation into the DNA. This ensured high loading efficacy. The loading could be easily visualized: doxorubicin loaded hydrogel looks orange in white light and pink in UV. The fluorescent nature of both the carbon dot as well as the drug load makes it easy to visualize the drug loading and release.

When HeLa cells were incubated with the drug alone and hydrogel encapsulated drug, they found that the hydrogel affected cell viability less, initially. This higher survival indicated that the initial burst phase was restricted and the drug was released in a slow and sustained manner.

The researchers believe that such hydrogel-based drug delivery systems are a promising strategy not just for cancer but also for the treatment of other diseases.

Carbon, **114**, 169–176

Algorithm to Find Disease Genes

Genes in DNA carry information about how our body is made and how it functions. Mutations in these genes may lead to genetic diseases: cystic fibrosis, sickle cell anaemia, Parkinson's disease, some types of cancers, etc. The challenge for scientists is to find which genes are affected in each of these diseases.

Last fortnight, Pradipta Maji from the Indian Statistical Institute, Kolkata, with Ekta Shah and Sushmita Paul from the IIT-Jodhpur reported a new gene selection algorithm, RelSim, to identify disease genes. About thirty thousand genes in our DNA make thousands of proteins. These proteins interact with each other to carry out their respective functions. Interacting proteins form a protein–protein interaction network with each protein placed at the nodes. If any of these

interactions malfunctions, it may lead to disease. The scientists combined the information on gene expression profiles and protein–protein interaction networks to create their algorithm.

To test the algorithm, the researchers applied it to many cancer datasets. They could identify several genes significantly linked with the corresponding disease. Then they used the algorithm exclusively on colorectal cancer datasets. And they established that their algorithm can detect more colorectal cancer genes than other disease gene identification methods.

The researchers plan to improve their algorithm further, to make RelSim a useful and powerful tool for identifying other disease-related genes.

Information Sciences, **384**, 110–125

Ethanol from Lignocellulose

Lignocellulosic biomass represents a large feedstock for bioethanol production. However, the costs associated with producing biofuel using lignocellulases represent a limiting factor in the development of a biomass conversion process.

Scientists at the CSIR IICT, Hyderabad, collaborated with scientists in Egypt and Australia to explore *Pongamia pinnata* seed residue as a low cost resource for ethanol production. *P. pinnata* seeds are composed of 30–35% oil which can be processed to biodiesel. The residue after extraction of oil has holocellulose, which can be hydrolysed to sugars and fermented for bioethanol production. So, the researchers used the de-oiled seed residue as feedstock for ethanol production.

Enzymatic hydrolysis of the seed residue using cellulase results in significant yield of sugars. But the scientists explored another possibility: growing microorganisms that produce lignocellulases on de-oiled seed residue. They selected two microorganisms – *Spingomonas echinoides*, a bacterial strain, and *Iprex lacteus*, a white rot fungus. And they found that these organisms were able to produce a wide array of lignocellulase enzymes while growing on *P. pinnata* seed residue. Solid state fermentation using both the strains produced lignocellulases with high activity, 10–50 times greater than that observed in liquid cultures! So the organisms can be useful for the hydrolysis of biomass, while doubling up as a source of lignocellulases.

Pongamia pinnata seed residue is a cheap inedible resource for both lignocellulases and ethanol production. It has the potential to produce ethanol in an efficient manner compared to other costlier resources. And, most importantly, the technique improves the economics of *P. pinnata* biodiesel production.

Renewable Energy, **103**, 682–687

Pomegranate and Grapefruit
Extend storage of fruits of sea

White shrimps, with high protein and low fat content, are nutritive and a commercially important seafood. Its aquaculture in Asia has rapidly increased over the last decade. India now exports frozen shrimps to the USA, the European Union, the UAE and Japan.

Shrimps have short-shelf life due to degrading enzymes. Exporters need to preserve freshness and maintain quality from harvest to delivery. So several preservation methods are in use such as low-temperature preservation, modified atmosphere, chemical as well as biological preservation. But importing countries have strict sanitary standards and zero tolerance to use of chemicals and antibiotics in preservation.

Researchers from the Anna University, Chennai, now report an effective alternative to chemical preservatives: extracts of fruit peels and seeds. They used extracts of pomegranate, grape and grapefruit wastes. Shrimp samples were treated with four different extracts: (a) pomegranate peel, (b) pomegranate seeds, (c) grape seeds, (d) grapefruit seeds and left to dry at ambient temperature for a few minutes in an aseptic condition.

Samples were then packaged using different methods. Some were packed in vacuum pouches containing different transmission rates of O_2 and CO_2. Some were subjected to packaging with various percentages and combinations of gases and stored at 3°C.

Different parameters including bacterial load, sensory evaluation of colour and odour were recorded every third day for 24 days of storage. Samples treated with extracts of pomegranate peel and grapefruit seeds combined with modified atmospheric packaging without oxygen and increased CO_2 were found to have very good quality and great antibacterial property.

Such fruit-based extracts which are biosecure, eco-friendly and cost-efficient will have a better market than chemicals for preserving the fruits of the sea.

LWT-Food Science and Technology, **77**, 217–224

Chicken Sausage with Sugars
Fermentation by L. plantarum

Antioxidants are endogenous compounds in food. They increase nutritional benefit and preserve lipid components from deterioration. Lactic acid bacteria are an important natural source of antioxidants, used in industrial fermentation. The ability of the lactic acid bacteria, *Lactobacillus plantarum*, to produce desirable effects in sausages depends on the processing of food such as heating which may kill the bacteria and their sensitivity to curing salts, spices and other ingredients used.

Last fortnight, scientists from the ICAR-Central Avian Research Institute, Izatnagar, devised a novel approach to protect *L. plantarum* throughout the process of sausage preparation, including heat processing. White Leghorn was deboned, minced and mixed with *L. plantarum* using dextrose and starch as substrates in different formulations. There were two controls: one containing only meat and the other with meat and *L. plantarum*. Both control and treatment formulations were divided into two parts. One was used for making an emulsion, with spices and condiments added, which was cooked at more than 100°C. The other was fermented with *L. plantarum*. After fermentation for 24 hours, ingredients were added and the meat was cooked.

The researchers performed antioxidant, pH and free fatty acid analyses on the meat, with and without fermentation. And they evaluated the microbiological quality and sensory properties of the fermented sausages.

The antioxidant profile and sensory scores of *L. plantarum* fermented sausages, with added dextrose and starch, performed better than those of conventional sausages. *L. plantarum* also protects the ingredients with the antimicrobial effect it exerts due to the addition of sugars. This potential of *L. plantarum* could find industrial applications for making healthier minced meat.

LWT-Food Science and Technology, **77**, 249–258

Unmanned Aerial Vehicle

Solar energy to power conversion

The Unmanned Aerial Vehicle (UAV) is in demand for use in intelligence and surveillance operations. Aviation fuels used to power aircrafts are petroleum based and contribute to greenhouse gases. Moreover, aircraft engines are too noisy for surveillance. So, the power has to come from the battery. However, battery power is restricted.

Last fortnight, B. S. Karthik Reddy and Aneesh Poondlaa from the VIT University, Vellore, Tamil Nadu, proposed a conceptual design for a solar powered UAV. They built an experimental plane using lightweight balsa wood and carbon fibre rods. The gross weight of the plane was 2 kg. They chose a 3 S battery, which consists of 3 lithium-polymer batteries connected in series and used it as a single unit. For a constant safe charging voltage of 12.4 V for the 3 S battery, 24 solar cells were connected. The solar cells are arranged in series on top of the wing, and supplied the required voltage for charging the battery. And the battery power was supplied to the motor such that it shuts down during constant level flight, to save energy. The central part of the wing containing solar cells is perpendicular to the fuselage, and parallel to the ground for maximum efficiency.

The researchers analysed the energy efficiency, exergy and power conversion efficiency to work out the feasibility of the design of a solar powered UAV. The energy needed to power the entire plane was conceptually analysed. They also analysed exergy, the maximum work possible during the process for equilibrium with the surroundings. The energy and exergy efficiencies were calculated for a solar wing by considering the mixed effect of both temperature and wind speed.

And then they tested the results of the analysis with experimental flights. It was observed that energy efficiency, exergy and power conversion decrease slowly during morning, remain low in the afternoon and start rising in the evening due to high ratio of output to input voltage. Higher global solar radiation and lower outdoor temperature were favourable for both exergy and power conversion efficiency. The energy efficiency was found to be always higher than that of exergy and power conversion. The UAV built by the team could fly for more than 6 hours using only solar energy which can be further increased by storing the excess energy in the battery.

These findings can be utilized for meeting the demand for an unlimited inexhaustible source of energy for UAVs, thus decreasing greenhouse gas emission to a large extent.

Renewable Energy, **104**, 20–29

Risk Analysis of Nuclear Plants

The risk associated with nuclear power plants is a major concern all over the world. Existing risk calculation methodologies address risks associated with a single reactor. The Fukushima accident has raised the need for second-thoughts on this method, especially when the site hosts multiple nuclear plants. Nuclear power generating sites around the world are mostly twin or multiunit sites. With no acceptable methodology to assess the risk posed by multi-unit nuclear plant sites anywhere in the world, Mahendra Prasad and team from BARC, Mumbai, proposed a holistic framework to do this. The strategy was to integrate the risk from all units, dependencies on external events and operation time of individual units.

The team has put forward two analytical approaches. The first one combines the risks associated with each unit considering them as constant values while the second approach combines the risks considering them as random variables.

The first method takes into account core damage frequency and operational years of each of the units. The probability of core damage resulting from internal as well as external events of each unit was also separately considered.

The result of a case study on hypothetical data shows that site level core damage frequency is not a sum of effects of all units but around 18% higher than unit level effect.

By using the second method, this effect was found to be 50% higher than the risk effect of a single unit. The scientists comment that the second method is technically correct as it relies on data on failure rate and the failure probability of components.

The new methodology takes into consideration external dependencies as well as the combined effect of all the units within the site. And it confirms that installing nuclear reactors of advanced design at the site, along with the old reactors, reduces the combined risk of the site.

Nuclear regulatory authorities, the world over, now have a new risk assessment methodology to consider for making nuclear sites safer.

Progress in Nuclear Energy, **96**, 56–61

Reports by: **A. C. Surya Prabha, Shumaila Afrin, Amit Narendra Landge, Divya Khatter, Sanghamitra Deobhanj, G. Sharath Chandra, Manish Kumar Tekam, S. Malarvannan, M. Rajkumar, G. V. Subashini, H. M. Mahadeva Swamy, Jose Mathew, Saravanan Parameswaran, Roopkatha Bhattacharya, P. Vijisha** and **Manoj Praveen**

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Science Last Fortnight

Detecting Iron

In drinking water

Drinking water contains varying levels of iron. Iron is essential for haemoglobin formation but high consumption causes health issues such as heart disease, arthritis, diabetes, liver disease and risk of cancer. High levels also impart an unpleasant taste and odour to drinking water and the use of such water for household chores can lead to brown stains on utensils and clothes. According to the World Health Organization, the permissible limit for iron in drinking water is 2 mg/l. Unfortunately, current methods to check iron in water are not sensitive and lack specificity.

Now, Kavita Tapadia and team at the National Institute of Technology, Raipur, Chhattisgarh, have developed a sensitive method to determine iron levels in water samples. The scientists first converted ferrous to ferric oxide and then added thiocyanate to form a ferric–thiocyanate complex. To remove non-specific elements, this complex was then extracted with N-octylacetamide at acidic pH. The extracted organic mixture was measured on a nanodrop spectrophotometric machine to estimate iron concentration.

The scientists tested the sensitivity and validity of this method by using it to estimate iron levels in various biological and environmental samples such as food grains, urine, blood and water samples. They also cross checked their results using Fourier Transform Infrared Spectroscopy and Nuclear Magnetic Resonance Spectroscopy analysis.

They claim that this method is cost-effective, sensitive and specific in nature, and will allow the estimation of even low levels of iron in water samples. Municipal corporations and regulatory authorities could use this method to monitor food and drinking water provided to the public.

Food Chemistry, **221**, 1415–1420

Detergent in Milk

Milk is easily available and rich in protein. Since it is always in demand, vendors often adulterate milk. Water, glucose, urea and detergents such as lissapol are common adulterants found in milk. Lissapol is a harmful anionic detergent containing alkyl benzene sulphonate. It causes skin and eye irritation.

In order to quantify this adulterant in milk, scientists from the Central Institute of Post-Harvest Engineering and Technology, Ludhiana, examined adulterated milk samples and compared them with pure milk.

They used Fourier Transform Infrared Spectroscopy to examine the chemical components of anionic detergent, detected as peaks. And Partial Least Square Software to analyse the data generated. This method is sensitive enough to detect even 0.2% detergent in milk, at a 5% significance level.

Such a tool for detection of detergents at milk collection points in cooperatives would ensure safer milk.

Food Chemistry, **221**, 815–821

Wheat: Facing the Heat

Rising global temperatures are predicted to reduce crop yields. Food shortage looms.

Wheat is hypersensitive to high temperature stress, but like other plants, it has mechanisms to survive such stresses. To look at how well different wheat varieties respond to high temperature stress, N. Chakraborty and team from the National Institute of Plant Genome Research, JNU, New Delhi, grew 9 cultivars – Unnat Halna, Halna, Raj3765, C306, NIAW34, WR544, WH730, HD2877 and PBW343. They grew some plants at 23°C and some others were exposed to 38°C.

The reduction in water content of leaves was least in Unnat Halna and WH730, and greatest in PBW343 and HD2877. Holding water, maintaining membrane integrity and preventing chlorophyll degradation are necessary for photosynthesis, which allows plants to produce sugar, and ultimately, grain. Unnat Halna performed best, and PBW343 performed worst, in most other parameters such as membrane integrity, proline and protein content, chlorophyll degradation, carotenoid/phytophenol content and production of heat-shock proteins. Heat-shock proteins initiate several cellular pathways involved in surviving high temperatures.

Based on the study, the nine cultivars were divided into three classes according to their heat tolerance. The most tolerant, Unnat Halna, also known as K-9423, was developed by CSAUA&T Kanpur, and is used as a variety sown late in the season. Finding more heat tolerant varieties and popularizing them will be the next challenge in climate change mitigation efforts.

Food Chemistry, **221**, 1077–1087

Spicing up Drugs?

Zerumbone from ginger

The emerging trend of microbial strains turning resistant to existing antibiotics has created the need for alternatives to combat infections. Likely candidates, bioactive compounds from plants and animals also offer little or no side effects. The essential oils of ginger contain a phytochemical, zerumbone. This highly reactive molecule is amenable to conjugate additions and asymmetric reactions – an excellent molecule for tailor made drugs.

Last fortnight, in Mysuru, B. K. Bettadaiah, P. S. Negi and team, from the CSIR-Central Food Technological Institute, oxidized zerumbone with selenium oxide to convert it into a zerumbone–bicarbonyl analogue. This new synthetic compound showed bactericidal activity against pathogens such as *Staphylococcus aureus*, *Bacillus cereus*, *Yersinia enterocolitica* and *Escherichia coli*. Antibacterial activity varied: it is most active against *B. cereus*. *Y. enterocolitica* was most resistant.

This derivative compound also exhibited antimutagenic activity against *Salmonella typhimurium* tester strains. Thus, it reduces the chances of the emergence of resistant strains.

With the potential for use in synthetic drugs, this natural compound, zerumbone, when structurally and chemically modified, can be used to treat various bacterial diseases.

Since the derivatives of zerumbone have applications in food preservation and in cancer treatment, pharmaceutical companies can now use it to tailor compounds for effective therapeutic and preservative properties.

Food Chemistry, **221**, 576–581

Laser Technique

To identify minerals in cucurbits

Cucurbits are used in salads, sweets, desserts and soups. However, seeds and rind, a large part of the cucurbit, are discarded. This waste is rich in minerals. Yet, so far, we lack precise data about the contents and their distribution in this nutritional treasure chest. Existing techniques for their detecting and identifying nutritional components are time-consuming and sample preparation is tedious.

Last fortnight, a research team from the University of Allahabad used a rapid technique, Laser Induced Breakdown Spectroscopy, to quantify minerals in cucurbit seeds. The technique analyses the spectral lines emitted from the plasma generated by the interaction of the laser pulse with the sample. The scientists used a setup with a laser source, a spectrometer, and a detection system. They used a Q-switched Nd : YAG laser at 532 nm with pulse width 4 ns at 2 Hz.

They calibrated the system for quantitative analysis and recorded the spectra of the seed samples. The Laser Induced Breakdown Spectroscopy spectra revealed the presence of calcium, nitrogen, hydrogen, carbon, sodium, potassium and magnesium.

They then compared the results obtained from Laser Induced Breakdown Spectroscopy with that from the existing Atomic Absorption Spectrophotometer method. The two methods showed very slight difference, ranging from 1.78% to 10.9%.

The scientists also applied Principal Component Analysis to the spectral data for categorizing the seed samples. They found four distinct groups.

Cucurbit seeds could now be used to enrich food products with mineral nutrients. The adoption of this simple rapid technique can help us identify more such wasted food resources.

Food Chemistry, **221**, 1778–1783

Keeping Coriander Fresh for Longer

Coriander leaves are a staple in most Indian households: an essential ingredient in many chutneys, salads, curries, etc. Sadly, unlike many veggies, coriander leaves are very susceptible to spoilage. Sourcing fresh crisp coriander leaves is, thus, inconceivable for many.

Cut fruits and vegetables spoil much faster than their uncut counterparts because tissue injury results in enhanced respiration rates, enzyme activation and consequent microbial overgrowth. This is more so with leaves such as those of coriander. Food scientists have been searching for minimal processing techniques to improve the shelf life of such foods without compromising on their nutrient value or taste.

Last fortnight, Ranjitha and colleagues, at the Indian Institute of Horticultural Research, Bengaluru, devised a method to improve the shelf life of cut coriander leaves while retaining flavour, taste and antioxidants levels. They soaked freshly uprooted, cut and washed coriander leaves in various chemical solutions, known for their antibrowning and antimicrobial properties, for five minutes each. In the following days, they observed the leaves for wilting, browning, etc. Treatment with kinetin showed the best results in terms of freshness. Kinetin, a major plant hormone, is approved of by the US Environmental Protection Agency as a 'Generally Recommended as Safe' chemical for post-harvest applications in fresh produce.

The researchers then proceeded to investigate the best packaging option, using a variety of plastics. The plastic bags helped maintain the treated leaves in a 'modified atmosphere' and helped prevent spoilage. They analysed various parameters including antioxidant levels, microbial growth, flavour, etc. Pretreatment with kinetin at 50 ppm, followed by packing in 25 µm polypropylene bags was shown to produce the best result, extending the shelf life of the leaves to 21 days when stored at 8°C.

A practical, healthy solution such as this would be a boon to the average urbanite, who cannot afford to maintain an herb garden at home. That being said, we can only hope that the results of this study hit the market soon. Vegetable traders, are you listening?

Food Chemistry, **221**, 844–854

Carp Roe Powder

No longer a bitter pill

Fish eggs (roe) are a popular source of high protein. Their amino acid and essential fatty acid content provide great nutritional value. This content enhances their flavour and taste. However, it also facilitates rancidity and a bitter taste quickly develops during processing and storing. So, processing plants remove fatty acids before marketing fish roe. And this reduces the nutritional value.

P. K. Binsi and team from the ICAR-Central Institute of Fisheries Technology, Cochin, collaborated with scientists from the ICAR-Indian Institute of Natural Resins and Gums, Ranchi, to devise a stable and non-conventional method for processing and preserving fish roe. The scientists stabilized the roe by emulsification with gum arabic. Then they spray dried this to powder form. This process encapsulated the lipid fraction of the roe mass of the *Rohu* fish – *Labeo rohita* – so that the oil droplets were trapped in a layer of protein. Now the fish roe are protected from oxidation and rancidity.

As a result, the shelf life of the powder is longer and, hence, it can be used in various forms of cuisines.

The scientists also did *in vitro* experiments with the encapsulated fish roe and showed that the fatty acids

were released in the intestinal tract. The results indicate that this nutritionally rich roe powder with high quality lipid composition can be used effectively in health formulations.

This method is timely given the dearth of research in India on the processing and storing of fish roe. With worldwide demand for this delicacy, industrialists and entrepreneurs can now net rich returns using this method.

Food Chemistry, **221**, 1698–1708

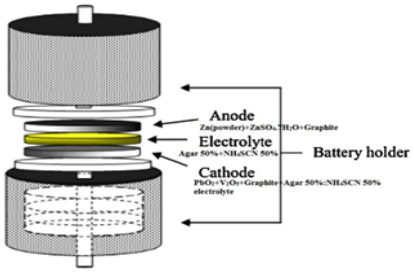
Agar–Agar Biopolymer
Electrochemical cell application

Agar–agar, a naturally occurring polysaccharide, has excellent film forming properties. Abundant, low cost and easy to process. Though agar–agar based electrolytes show promise for many applications, so far, they have not been used in electrochemical batteries.

Now, a research team from the S.F.R. College for Women, Sivakasi, in collaboration with the Materials Research Centre, Coimbatore, has devised an agar–agar based polymer electrolyte. They used ammonium thiocyanate and agar–agar. With distilled water as solvent, they used the solution casting technique to prepare the electrolyte.

FTIR revealed the formation of a complex of the salt with the polymer. XRD analysis showed the amorphous nature of the polymer complex.

A 50 mol% agar and NH_4SCN film showed maximum conductivity at ambient temperature. The scientists studied the conductivity with alternating current impedance spectroscopy. The highest conductivity sample had low activation energy – only 0.25 eV. The Wagner's DC polarization technique revealed that the conductivity in Agar–NH_4SCN films is due to ion transport.



Schematic diagram: Electrochemical cell

The researchers also determined the glass transition temperature of the electrolyte. Differential Scanning Calorimetry analysis indicated that the temperature range of pure agar decreases with the addition of NH_4SCN. This helps soften the polymer backbone and increase its segmental motion. These parameters ensure that the prepared polymer electrolyte is a good candidate for low-cost biopolymer electrolyte membranes in fuel cell applications and solid state devices.

Given the low cost components and the simple procedure, and that the electrolyte is highly scalable, and nontoxic, there is hope that it will soon find real life applications.

J. Appl. Poym. Sci., **134**(15), 44702

Seaweed to Clean Water
Alginate nanocomposite

An unlikely magic bullet has emerged in the race to protect our increasingly threatened environment: alginate, from brown seaweed. This non-toxic, biodegradable, and biocompatible material is the basis for the design of a nanocomposite ion exchanger.

Last fortnight, Deepak Pathania and team from the Shoolini University, Himachal Pradesh, in collaboration with the University of South Africa, reported synthesis of an ion exchanger that can separate heavy metals and remove organics as well as microbial contaminants from wastewater.

The researchers prepared the nanocomposite ion exchanger using alginate, zirconium oxychloride, orthophosphoric acid and nitric acid. The team determined the physicochemical properties of the ion-exchanger such as ion exchange capacity, thermal characteristics, elutant concentration, elution behaviour, pH titration and the distribution of metal ions. The scientists also checked its capacity to separate heavy metals, degrade organic dyes as well as its antimicrobial activity. They found that the nanocomposite ion-exchanger was highly selective for Al^{3+} and Mg^{2+} ions.

This ion exchanger is more efficient than chemical precipitation, complexation using natural and synthetic reagents, reverse osmosis, electro dialysis, electrochemical membrane reduction, coagulation, flocculation, adsorption and chemical deposition. Besides, it has thermal and mechanical stability. Reproducibility and higher selectivity for metal ions make this new material even more attractive.

Since the alginate–Zr(IV) phosphate nanocomposite has the potential for diverse applications in the removal of metals, organic and microbial contamination from the environment, the team hopes that it may, one day, help industrialists better comply with environmental regulations.

J. Alloys Compounds, **701**, 153–162

Early Detection of CNS Disorders

Central nervous system disorders like Alzheimer's, schizophrenia, Huntington's, AIDS, Dementia Complex, etc. reduce the quality of life. Early diagnosis can help us better deal with these disorders.

In the human body, an increase of 10–40 micromolars in the levels of quinolinic acid indicates the onset of these disorders. This excitotoxin, present in less than 100 nM concentration in healthy humans, is a metabolite of the kynurenic pathway. This pathway has a link with neurodegenerative disorders. It metabolizes tryptophan to produce nicotinamide adenosine dinucleotide (NAD). Any disturbance in this pathway results in increased levels of quinolinic acid. Early detection of increase in quinolinic acid thus helps deal with these disorders.

Last fortnight, R. K. Singh and team, from the Banaras Hindu University, in collaboration with the Delhi Technology University, devised a sensitive electrochemical method for early diagnosis of central nervous system disorders.

The scientists fabricated an electrode using bovine serum albumin, quinolinate phosphoribosyl transferase, reduced graphene oxide and indium tin oxide. They coated reduced graphene oxide on an indium tin oxide coated glass plate using the electrophoretic deposition method. Quinolinate phosphoribosyl transferase was immobilized on this. The enzyme forms an amide bond with reduced graphene oxide. This immobilized enzyme binds with quinolinic acid and emits electrochemical

signals that can be detected. Nonspecific sites were blocked by bovine serum albumin, increasing the selectivity of the bioelectrode.

The researchers used differential pulse voltammetry to measure the concentration of quinolinic in patient samples. The excitotoxin concentration is directly proportional to the magnitude of current. The biosensor is capable of detecting quinolinic acid in micromolar to millimolar range. The scientists determined the shelf life of the biosensor and found that it can be kept for 30 days at 4°C.

Selectivity, reproducibility and sensitivity give this electrochemical biosensor an edge over conventional methods for detecting quinolinic acid in biological samples. One day, every diagnostic lab might use this biosensor for the early detection of the onset of CNS disorders.

Biosensor and Bioelectronics, **90**, 224–229

Agents of Contrast

Rod shaped iron oxide

Magnetic Resonance Imaging (MRI) traces the positions of molecules in the body by varying the magnetic field. And shows details of specific organs or blood vessels. MRI scans are generated by radio frequency pulses. Varying the pulse sequences creates a contrast between tissues. This contrast is like a signature for different tissues. Some tissues have a natural contrast on MRI, but for specific types of imaging, a MRI contrast agent is needed to intensify the imaging of target tissue.

Last fortnight, D. Bahadur and team from the Indian Institute of Technology, Mumbai, in collaboration with researchers from the Dr Balabhai Nanavati Hospital and Research Centre reported using nanorod shaped iron oxide nanoparticles as contrasting agent. These have unique superparamagnetic properties.

The magnetic properties depend on the size and shape of the nanoparticles. Instead of using spherical particles, they opted for rods. This gives higher surface area, stronger magnetic field and larger effective diameter than the spherical. And enhances contrast value, thus producing better images. The researchers found that iron oxide nanoparticles produce high contrasts in MRI.

Iron oxide nanoparticles have been used earlier for targeted drug delivery, enzyme immobilization and magnetic bio-separation. The team capped the nanoparticles with silicon to enhance delivery capabilities. They found that these capped particles had good aqueous stability and biocompatibility.

These initial tests show that iron oxide nanoparticles are effective contrast agents. And can also deliver drugs when capped with silicon. Useful properties for imaging of targeted anticancer drug delivery.

J. Magn. Magn. Mater., **428**, 340–347

Batteries – Rest in Peace

Supercapacitors for super storage

Smartphones are constant companions but their battery life can be a let-down. Scientists hope that supercapacitors will soon replace lithium-ion batteries in smartphones. However, existing capacitor materials and technologies offer limited energy storage capacity.

Last fortnight, Saptarshi Dhibar and Chapal Kumar Das from IIT Kharagpur reported developing a method to fabricate silver-polypyrrole/graphene nanocomposite electrodes with increased capacity.

They fabricated the material using *in situ* polymerization with ammonium persulphate as oxidizing agent in the presence of silver nitrate and dodecylbenzenesulphonic acid. They added sonicated graphene and pyrrole monomer solution in a stepwise manner to a silver nitrate solution to create the silver–polypyrrole/graphene nanocomposite. Graphene improved electrical conductivity of silver nanoparticles. The nanocomposite also shows better power density and thermal stability than existing electrodes fabricated with conventional methods.

The team also assessed the difference in performance between this electrode and one made of only silver-polypyrrole. They examined both electrodes using various spectroscopic techniques such as FTIR, UV-visible, and Raman analysis. The silver-polypyrrole/graphene nanocomposite developed has a structure where graphene is uniformly coated with polypyrrole in the presence of silver nanoparticles. It has a special morphology which enhances its electrochemical performance.

The electrochemical properties of the silver-polypyrrole/graphene nanocomposites have implications in the energy and electronics sector. Their properties make them excellent electrode material for next-generation supercapacitors with good energy storage capacities. Soon we might be able to use smartphones for days on end, without charging.

J. Appl. Polym. Sci., **133**, 44724

Reports by: **Aditi Jain, D. Kavya, Jose Mathew, Jinsu Varghese, A. C. Surya Prabha, S. N. Savitha, R. Baskar, H. M. Mahadevaswamy, Manish Kumar Tekam, Neeta Shrivastava, Sudarshana Dhar** and **Geetha Sugumaran**

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Science Last Fortnight

De-fluoridating Water

Ionic liquid-functionalized alumina

Fluoride in drinking water causes dental and skeletal problems. Water is defluoridated by precipitation, electrocoagulation, electrodialysis, membrane filtration, ion exchange or adsorption. Adsorption has proved the most promising among these methods. Hydroxyapatite, activated carbon, metal oxide, clays, chitin-chitosan, alum, lime and activated alumina are commonly used as adsorbent.

Last fortnight, Patel and co-workers from the National Institute of Technology, Rourkela, reported synthesizing a new adsorbent: ionic liquid-functionalized alumina. Activated alumina is widely used as adsorbent to remove fluoride. However, it has limitations: at higher pH fluoride adsorption is reduced and there is leaching of aluminium.

The researchers used La^{3+} modified and alum-impregnated activated alumina as well as mesoporous alumina, with an anionic surfactant. They reported an increase in adsorption due to this modification. Since it has affinity to fluoride, it is effective for the removal of fluoride from contaminated water.

The team examined the shape, size, morphology, structure, chemical composition and phase of the material using Fourier transform infrared spectroscopy, X-ray powder diffraction, thermogravimetric analysis, N_2 adsorption–desorption isotherm, transmission electron microscopy, X-ray spectroscopy elemental mapping, field emission scanning electron microscopy, and X-ray photoelectron spectroscopy. These tests validated the adsorbent capacity. The reasons for high adsorption include electrostatic interaction and ion exchange.

'Ionic liquid-functionalized alumina as an adsorbent for fluoride removal has not been demonstrated earlier', says Patel. Alumina release is a major consideration in fluoride removal using activated alumina or alumina-based composites. It leads to secondary aluminium contamination in water. Aluminium exposure is also a risk factor for the Alzheimer disease. 'The amount of aluminium released by this alumina absorbent is far below WHO drinking water standards' add the researchers. This material might prove useful to overcome fluoride contamination in water.

J. Clean. Prod., **151**, 303–318

Cucumber Peels

Removing lead from water

Lead contaminates water bodies and in humans, chronic intake can result in kidney, liver and brain damage. It also leads to dizziness, depression and loss of memory.

Last fortnight, scientists at the Jadavpur University and the Indian Association for the Cultivation of Science, Kolkata, reported a simple method to remove lead from polluted water using cucumber peels. They did a series of analyses to study the moisture, ash, cellulose, hemicellulose and lignin content of the peels to evaluate its use as adsorbent. Thermogravimetric analysis demonstrated that, among the three biopolymers, hemicellulose degraded fastest and lignin slowest with rise in temperature. Zeta potential measurements further revealed that surface charge of cucumber peel biomass is primarily negative at pH above 2. This helps in lead absorption.

Using scanning electron microscopy, energy dispersive X-ray analysis, X-ray diffraction analysis and Fourier transform infrared spectroscopy they studied the morphological properties of the peels. Various chemical modifications of functional groups revealed significant role of carboxyl and phosphate groups in adsorption of lead.

The researchers also tested adsorption of lead by cucumber peels in the presence of cadmium and confirmed that the peels adsorb lead even in the presence of the co-ion. Further, desorption experiments showed that lead can be efficiently desorbed and the peels can be reused, making them a cost effective material.

Entrepreneurs and bioengineers can now develop materials based on cucumber peels for green and clean water filtering units!

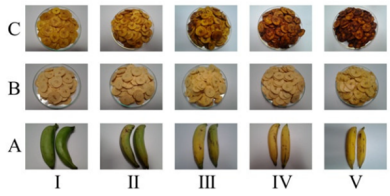
J. Clean. Prod., **151**, 603–615

Safe Banana Snacks

Reducing toxicity in banana chips

Acrylamide is a contaminant in high temperature processed food products such as banana chips. Since banana is a rich source of carbohydrate, acrylamide forms when bananas are deep fried. This depends on whether the banana is ripe or not. However, we lack precise data on how maturity affects acrylamide formation.

Nisha and team, from the CSIR-National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram, recently analysed chemical changes during the different ripening stages of the *Nendran* banana and correlated them with acrylamide formation.



The scientists detected and quantified the precursors of carbohydrates, proteins, and polyphenols using the HPLC method. In all five ripening stages, they correlated reducing sugars, amino acids, as well as total phenolic and flavonoid content using Pearson's correlation coefficient.

The team found that reducing sugars, such as glucose and fructose, showed a positive correlation with acrylamide formation whereas amino acids showed poor correlation. The total phenolic content showed a decline. The flavonoid content in the unripe stage is significantly higher than that in the ripened stage of plantain.

The banana chip makers can now select the most appropriately ripened bananas to reduce the level of acrylamide.

Food Chem., **222**, 53–60

Diabetic Retinopathy

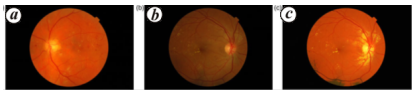
Better image processing

Diabetes, a dreadful disease in itself, also affects vision. Diabetic retinopathy, one such complication, can cause irreparable damage to the blood vessels of the retina. Though it may initially show no symptoms or only appear as

mild vision problems, it can cause blindness if untreated.

Last fortnight a team of scientists, from the Amity School of Engineering and Technology, Noida, proposed an automatic image processing method to efficiently detect and accurately grade the severity of diabetic retinopathy. They took images of the ocular fundus or inner lining of the eye with a special camera. And used an algorithm to do a region-based computation of the image.

Three pre-processing steps are done to detect exudates, protein coagulations in the fundus: first, colour is normalized, then contrast is enhanced, and, lastly, background shade is corrected. This region-based identification of various abnormalities is much faster and has less complexity.



(***a***) Fundus image (reference for normalization), (***b***) input image, (***c***) colour normalized image.

In existing methods, algorithms use the image of the entire fundus. This takes more time and requires additional methods for grading the severity of the disease. In the proposed method, however, the region around the macula, an oval-shaped pigmented area near the centre of the retina, is segmented into various sub-regions. Diabetic retinopathy affects each sub-region in varying degrees of severity. This method provides more accurate, better quality results.

Another important finding of this research is that any future detection algorithm can be adapted to this region-based scheme to reduce excess computational time. This study can also inspire researchers to find methods for classifying other stages of diabetic retinopathy.

Comput. Methods Biomech. Biomed. Eng., **5**(3), 195–207

Diabetic Cardiovascular Diseases

Role of lipoic acid synthase

Diabetes, a major health concern in itself, is also associated with cardiovascular disease, a leading cause of mortality. Research has shown that there is a link between diabetic cardiovascular diseases and oxidative stress which leads to mitochondrial dysfunction and also plays a role in the progression of the condition. An essential cofactor for several mitochondrial enzymes is lipoic acid which participates in glucose metabolism. It also serves as mitochondrial antioxidant. Recently, lipoic acid synthase has been identified in mammals. However, its role is not yet completely understood. Lack of structural information about the enzyme is hurdle to understanding its structure and function.

Last fortnight, researchers at the Prof. M. Viswanathan Diabetes Research Centre, Chennai, studied the enzyme that synthesizes lipoic acid. They predicted the structure of lipoic acid synthase from humans, using lipoyl synthase from the bacteria, *Thermosynechococcus elongatus*. Then, they predicted how the substrate, S-adenosylmethionine, interacts in the active site of the enzyme through molecular docking. Since they did structure prediction and docking studies in the absence of water, the predicted interactions were not reliable. So, they performed molecular dynamics simulation in the presence of water to mimic the environment of living systems.

The scientists found that the predicted structure of human lipoic acid synthase and its interaction with substrates is reliable. This knowledge might serve as starting point to design and develop drugs for diabetic cardiovascular diseases.

J. Theor. Biol., **420**, 259–266

Effective Drug Delivery

Alginate–gelatin polymer blends

The mode of administration of a drug can greatly affect its therapeutic action: pills, injections… Rate of release of the drug is also a governing factor. Various polymers, synthetic and biological, for the controlled delivery of drugs have been studied. Biopolymers have advantages over synthetic polymers and are also more suitable for oral administration. However, it is a challenge to maintain superior drug adsorption capacity, stability and sustained release with a single polymer.

Last fortnight, a team of researchers from the Indian Institute of Technology, Kharagpur, developed a blended polymer from alginate and gelatin with better adsorption, stability and sustained release. The alginate provides excellent absorption capacity while the gelatin gives mechanical strength.

To obtain the polymer blend, the researchers mixed sodium alginate and gelatin in distilled water and cooled it to 4°C in the presence of a surfactant for 12 hours. The consequent crosslinking of one of the polymers ensures that the entire mixture forms a uniform gel matrix.

The researchers soaked this matrix with vitamin B12 and tested it for controlled release at different temperatures and pH. The drug-coated matrix showed better adsorption and controlled release. Variation in temperature did not affect rate of release and stability.

There is a growing need to formulate dosage forms for the controlled release of drugs. The alginate–gelatin matrix offers a prolonged therapeutic effect at reduced dosing frequency. Drugs can thus be effectively delivered orally to cure many diseases.

J. Appl. Polym. Sci., **134**(18), 44787

Salve for Skin Cancers

Increased interest in skin cancer has focused attention on drug delivery. While many ailments can be cured by popping pills, in skin cancer, delivery via skin is the preferred mode. It is effective and its action is localized. Thus, side effects need not impact the whole body. However, such delivery has to penetrate several skin layers.

Last fortnight, Sahu and team from the Dr Harisingh Gour University, Sagar, used eucalyptus oil to coat a biodegradable nanogel polymer, entrapping 5-fluorouracil, a cancer drug, to increase penetration to the stratum corneum. The scientists assessed penetration efficiency, drug release capacity and drug release patterns on both human keratinocyte cell lines and pig skin. Their results showed that neither the coated nanogel nor drug release impacted the eucalyptus coating.

These findings indicate that this modification has the potential to overcome problems of drug penetration during skin delivery. Further validation with clinical trials can lead to better formulations for therapy.

J. Control. Rel., **253**, 122–136

Linen Shines Whiter

Linen, a bast fibre from flax, is gaining popularity as textile. It has natural gum and wax-like impurities that need to be removed before it can be used as textile. It is a difficult fabric to pre-treat for desired levels of absorbency and whiteness. Bleaching and scouring with chemicals during pretreatment often damage the fabric. The reduction in the fabric's tensile strength and texture needed addressing by researchers.

Abhishek C. Jadhav and Sanjeev R. Shukla from the Institute of Chemical Technology, Mumbai, collaborated with DyStar India Pvt Ltd to achieve a higher whiteness index while retaining the physicochemical properties of the fabric. The scientists adopted a method of cold oxidative bleaching, followed by wet on wet pad-steam scouring and bleaching. The pad-steamed and bleached fabric was then pad-dried.

The combined method of scouring and bleaching cleared the impurities, while maintaining the pH balance of the fabric. The scientists used an optical bleaching agent to consistently obtain a base whiteness at industrially accepted standards. The whiteness was also higher on a wash fastness rating with a lesser drop in tensile strength.

This process proved cost effective since it consumed less water and electricity. Moreover, it needed less labour. Linen can thus be made more economical and eco-friendly.

J. Text. Inst., **108**, 657–663

Eco-friendly Surfactants

The discharge of unprocessed synthetic surfactants into sewage systems or water bodies affects aquatic organisms and ecosystems. These surface-active agents are widely used as detergents. They help remove dirt from solid surfaces and trap it in suspension. Recently, there has been interest in exploring natural surfactants from plants, bacteria and fungi. Amongst plant-based surfactants, saponins are well known.

Last fortnight, researchers from the Sikkim University reported the use of saponins from *Zephyranthes carinata* Herbert, *Pyagi phool* or Pink Rain Lily, and *Sapindus mukorossi* Gaertn, *Ritha* or soap nut. Though we know that the first, an ornamental plant, is used to treat fever in Chinese medicine, and that the second is a cleaning agent, we still lack adequate information on the activity of their surfactants.

The team investigated the efficiency *Pyagi phool* bulbs and *Ritha* pods as natural surfactants by extracting their saponins in an aqueous solution. The scientists tested their foaming ability and stability, surface tension, viscosity, emulsification, wetting, cleaning and dirt dispersion properties. And compared these with those of Henko, a commercial surfactant. Saponins from the plants had better surface activity.

These plant materials are low-cost, biodegradable, renewable and easy to handle. Enhancing such alternative surfactants could make them candidates for industrial applications and reduce environmental problems posed by synthetic surfactants.

J. Clean. Prod., **150**, 127–134

Climate Responsive Architecture

Golconde dormitories

Air conditioners, coolers, fans and refrigerators are unavoidable in India, most regions of which experience a warm and humid tropical climate. This results in huge energy consumption. Ventilated buildings such as the Golconde dormitories, Puducherry, are an example of climate responsive architectural solutions. The 3-floor building has 51 rooms and a semi-basement. The longer axis of the building is oriented north-south with a tilt towards the south. The east and west walls contain small openings to decrease solar heat gain. Both north and south fronts of the building have horizontal asbestos cement louvers adjustable using levers.

Recently, Mona Doctor-Pingel and other scientists at the Centre for Scientific Research (CSR), Auroville, conducted a case-study on the Golconde dormitories. They continuously monitored the thermal performance of the building over one and a half years.

They found that the ventilated double roof, with an air gap of about 10–30 cm, acts as thermal insulator. The basement passage has significantly lower temperatures due to the landscaping strategy in the north and south gardens which creates a pressure difference. This leads to continuous air movement in the passage. The corridors in the north, connecting the rooms, are a buffer zone, reducing temperature inside the rooms. The louvers on the corridors protect the building from sun, wind and rain but allow ventilation.

The findings of this study can be used for constructing climate responsive buildings in other places. A good understanding of local climate and the use of passive design principles can help reduce energy demand and consumption.

Architect. Sci. Rev., **60**(3), 205–214

Waste as Cement Substitute

Efficient use of fluorogypsum

The disposal of fluorogypsum, a by-product of the hydrofluoric acid industry, poses a threat to the environment. Though there is research on repurposing value-added building products from by-products such as fly ash, blast furnace slag and phosphogypsum, we still lack precise data on the effective utilization of fluorogypsum.

Last fortnight, Garg and team from the Central Building Research Institute, Roorkee, developed a cement-free binder from fluorogypsum. They first mixed fluorogypsum with different chemical activators and examined setting time, compressive and flexural strength. The researchers found that the combination of fluorogypsum with anhydrous calcium chloride and sodium sulphate exhibited low setting time, high flexural strength and compressive strength.

They then tested the water absorption and porosity of the cement-free binder. The fluorogypsum binder showed lower water absorption and porosity, as well as higher strength than other cement compositions.

Scanning electron microscopy of the cement-free binder revealed prismatic, needle-shaped crystals with sharp boundaries which make the matrix dense and compact. This change in the morphology of the material explains the reduction in water absorption, porosity, and the enhancement in strength.

The team also tested this cement-free binder for use in masonry mortars, concrete, lightweight blocks and tiles. Masonry mortars prepared with fluorogypsum binder were excellent for use in plastering and masonry works. Fluorogypsum, once a waste by-product, now has potential as a new generation supplementary binder.

Eur. J. Environ. Civil Eng., **21**(5), 612–628

Freedom from Fossil Fuel

Solar airplanes and cars to solar powered airports! With fossil fuels dwindling, recent years have seen a surge towards solar energy. While solar technologies have been successful for small scale and domestic use, large scale heating processes in industries remain a challenge: the intermittence of sunlight, generation of heat to required temperature ranges for specific processes... These challenges require an understanding of the various parameters involved in collecting and converting solar energy for use in industries.

Recently, a team of researchers from the Centre for Study of Science, Technology and Policy, Bengaluru, developed a new methodology to estimate the potential of solar energy for heating processes in larger industries. N. S. Suresh and Badri S. Rao took various parameters into account to assess the feasibility of integrating solar collectors in industries: process operating temperatures to select the right kind of solar collectors, the size of the solar field along with thermal heat loads, type of working fluid used for heat generation, efficiency of the chosen solar collectors, location-based solar irradiance, etc.

They tested and quantified the potential of implementing the methodology in selected textile, pulp and paper, dairy, leather and automobile industries. These industries are highly energy demanding and depend on fossil fuels for operation. To approximate the viability of solar energy systems in industries, the researchers carried out a techno-economic analysis of the proposed methodology using the System Advisor Model software.

The results have strategic implications in the energy sector and large scale industries dependent on fossil fuels. Contrary to existing beliefs, the results indicate possibilities of integrating solar thermal collectors for process heating in industries and their gross potential. The study recommends the best solar collectors for various purposes and demonstrates the economic benefits in terms of capital cost, fuel oil savings, rates of returns, etc… It highlights environmental benefits in terms of carbon savings. The team also has policy recommendations to reduce the use of fossil fuels.

J. Clean. Prod., **151**, 439–451

Sourcing Fuel from Seaweed

Strange though it may sound, seaweed could now prove to be a viable alternative in the production of biofuel. Seaweed or microalgae thrive on nutrients from the sea. They are mostly cultivated for specialty food products. Seaweed biomass is rich in carbohydrates which can be converted to sugars. Thus they have potential as biofuel feedstock. But the fermentation of these sugars is difficult owing to their chemical composition.

Now, a research team from the MCRC, Chennai, in collaboration with the Alagappa University, Karaikudi, demonstrates that seaweed and its spent biomass can provide a renewable source for bioethanol production. They used spent biomass, from shade-dried red and brown seaweed to produce ethanol by biosaccharification–marine bacterial consortia to convert the complex carbohydrates into sugars and marine yeast for fermentation.

There was significant loss of sugars after the removal of pigments, phycocolloids, and pigment-phycocolloids when compared to its fresh biomass. They used two methods for the saccharification of the spent biomass: mild acid and marine bacterial consortia.

Total carbohydrate was greater in the fresh seaweeds *Gracilaria corticata* and *Sargassum wightii*, than the spent seaweed biomass. The industrial spent samples recorded higher reducing sugar production. The mild acid pretreatment followed by bacterial consortia recorded more sugar conversion and ethanol production than the samples subjected to bacterial saccharification.

The isolated marine yeast, *Meyerozyma guilliermondii*, produced maximum ethanol from spent biomass –2.74 and 1.72 g/l in *Sargassum ilicifolium* and *Gracilaria corticata* respectively. The spent biomass from the agar and alginate industry gave higher amount of ethanol –2.34 and 2.60 g/l of respectively, through saccharification using acid plus bacterial consortia and marine yeast fermentation.

The study concludes that seaweed solid wastes (spent biomass) can also be used as substrate for bioethanol production. Since 2/3rd of the earth is covered by seas, seaweeds appear to be a rich source of ethanol capable of meeting the global demand for transport fuel.

Renewable Energy, **105**, 133–139

Reports by: **R. Baskar, Jinsu Varghese, Naresh Kumar, Sanghamitra Deobhanj, Saravanan Parameswaran, G. Sharath Chandra, Aditi Jain, Pavithra P. Nayak, Pudi Venkatesu, Sudarshana Dhar, A. C. Surya Prabha, Geetha Sugumaran** and **H. M. Mahadevaswamy**

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Science Last Fortnight

Tilted Solar Still

Basin or wick

Most countries face acute shortage of potable water. Distillation of abundantly available seawater using freely available solar energy can easily solve the problem.

Solar stills use the sun's heat to evaporate polluted or saline water to produce potable water free from salts and pathogens. One such still uses a blackened basin, with small compartments for water to be treated. The other still uses a blackened woolen wick as evaporating surface to distribute water to be treated uniformly over it by capillary action. Both types of technologies are ecofriendly. Which one is better?

Reddy and team from IIT, Chennai, recently reported a comparative study of the distillate productivity as well as the thermal and exergy efficiency of the two types of solar stills. 'To convert brackish water into potable water with tilted solar still designs is an attractive option when compared with other available solar still designs', says Reddy.

They analysed the variation in the temperature profile of the basin water, wetted wick, air–vapour mixture, and glass cover of both the type of solar stills. The researchers also took into account the variation of distillate yield with global horizontal solar radiation intensity.

They found that the annual average yield of the tilted solar still with basin is higher than that of the unit with wick. The team recorded a maximum distillate yield of nearly 5 l/d for the tilted solar still with basin. It was 4.54 l/d for the still with wick. The yearly average thermal and exergy efficiency is also higher for the unit with basin. 'Both the solar stills produced distillate of high quality. But tilted solar still with basin has higher ecological and economic benefits', says Reddy.

The energy payback time of the tilted solar still with basin is nearly three years. And the costs are about 60 rupees for 20 l of distilled water at a 12% interest rate.

Desalination, **410:** 30–54

Purifying water

Best out of agro-waste

Heavy metal waste contaminates lakes and other water bodies. Consumption of contaminated water can impair liver, kidney and nervous system. Unfortunately, current purification methods are costly, lack efficiency and produce toxic sludge.

In a recent study, scientists from IIT Indore, in collaboration with the University of Illinois and the North Carolina Chapel University, reported the use of agro-waste based nanofibres for adsorbing heavy metals from contaminated water. They prepared these nanofibers using a solution of agro-wastes such as lignin, oats, soy protein, sodium alginate and chitosan, with nylon-6. This solution was then pressurized through a nozzle to make nanofibre mats. These mats were efficient in adsorbing lead from contaminated water. They found maximum adsorption of lead on lignin and soy containing nanofibre membranes. The presence of sulfhydryl, amine, hydroxyl, carboxylic acid and phenolic groups allows maximum adsorption of lead ions on nanofibre membranes.

The scientists then studied lead adsorption under through flow conditions. They tested the nanofibre mats in a range of pH variations and found that soy nanofibers adsorbed the highest amount of lead at a pH of 4.5. Doubling membrane thickness on the adsorption pattern, they find, leads to maximum adsorption of lead.

The researchers tested the physicochemical properties of this nanofibre. They found that it has high tensile strength. The use of such inexpensive agro-waste based nanofibers is scalable to industrial level water purification.

J. Membr. Sci., **530:** 250–263

Treating Textile Wastewater

Preventing environmental hazards

The textile dyeing industry is a major cause of water pollution. It uses more than 8000 chemicals. Most of these chemicals are toxic heavy metals and organic materials. They make water turbid and foul. This prevents penetration of light and oxygen into water, thus affecting photosynthesis and marine life. Consuming such water or even coming into contact with it can cause allergies and it is often carcinogenic. Current methods for removing textile wastes from water are expensive and inefficient.

Last fortnight, Pillai and Gupta from the Indian Institute of Technology, Kharagpur, developed a model for the efficient removal of textile waste from water. They configured the reactor with a parallel plate which produced a serpentine flow pattern for the electrochemical oxidation of textile wastewater. The configuration of the reactor plates provides greater surface area so that more wastewater can be treated.

The configuration completely removed textile waste from water. The chemical oxygen demand of synthetic textile wastewater was reduced by 90%. This reactor can be used to treat both synthetic dyes and natural textile chemical pollutants in wastewater.

The World Bank estimates that nearly 20% of industrial water pollution is due to textile dyeing. Producing a pair of jeans leads to the pollution of 1800 gallons of water! The continuous flow reactor efficiently treats textile wastewater pollution and prevents environmental hazards. Moreover, the reactor consumes less energy and is less expensive than available methods.

J. Environ. Manage., **193:** 524–531

Bora Glutinous Rice

Slow digestible starch

These days, diabetes, heart disease and obesity are on the rise. And quite often sugars and carbohydrates are

blamed. Are sugars and carbohydrates bad?

Starch is a naturally occurring dietary carbohydrate. It occurs in a granular form with a semi-crystalline structure, and a major portion of it may be rapidly digestible. Slow digesting starch takes longer to break down and is considered low-glycaemic: it provides energy without spiking the blood sugar.

The nutritional quality of starch depends on its structure and processing. Last fortnight, a research team from the Department of Food Engineering and Technology, Tezpur University, Assam, reported the effects of repeated cycled crystallization on digestibility. They studied the molecular structure of glutinous Bora rice starch. This rice has high amylopectin content and is popular as snacks: flat rice, puffed rice, etc. It is also used to make rice beer.

The research team standardized the repeated cycled crystallization conditions. The best method for slow digestible starch product development, they found, is to soak Bora rice in double the amount of water, and subject it to cycles of 24 hour heating and cooling between 4°C and 45°C. The slow digestible starch content increases from about 18% to more than 80%.

Fourier transform-infrared spectroscopy and X-ray diffraction studies revealed double helical reorientation within crystalline domains in the slow digestible starch product. This confirms an increase in imperfect crystallinity and molecular order in the optimal slow digestible starch product. The research team observed an increase in crystallinity and molecular weight along with resistance to digestion, in the slow digestible starch product. The repeated destructuring and restructuring of amylopectin enhances molecular interactions within and amidst adjacent amylopectin structures. This confers protection against enzyme digestion.

These results indicate that cycled crystallization is an appropriate procedure to produce slow digestible starch. This technique can be used to develop food and pharmaceutical products for tackling obesity, diabetes and cardiovascular disease.

Food Chem., **223:** 31–39

Biosensor for Jaundice

Bilirubin, a yellow compound, breaks down heme in our body. It is useful in clearing the waste products of haemoglobin breakdown in aged red blood cells. The normal level of bilirubin in human blood is < 25 μmol and, in jaundice, it increases to >50 μmol/l. This increase may explain the yellow colour of skin in jaundice.

Bilirubin is considered a biomarker because its concentration is associated with mortality and liver-diseases. Therefore, accurate detection of bilirubin concentration in human serum is important. Available clinical methods measure conjugated and total bilirubin using a classic spectrophotometric method based on endpoint diazo reactions. These methods have drawbacks such as low stability, degradation, decolouration, etc.

Last fortnight, scientists from the Madurai Kamaraj University and the Biotechnology Division, DRDE, Madhya Pradesh reported designing a fluorescent biosensor, based on an imine molecule, which helps determine bilirubin at two different pHs – 7.4 and 9.0. The scientists used the biosensor to detect bilirubin in human blood and urine samples.

The biosensor is sensitive and selective towards bilirubin, even in the presence of other interfering biomolecules and metal ions. From the results, it is clear that this biosensor is an excellent analytical tool for the diagnosis of jaundice.

The synthesis of the sensor is simple and cost effective. And it takes about 10 minutes to make it. Commercial scale production of the sensor may simplify tedious lab procedures and hasten diagnosis.

Biosensors Bioelectronics, **91:** 82–88

Gold Nano-clusters

Boon in cancer diagnosis

Gold nanoclusters are promising carriers of biomolecules like proteins, peptides, nucleic acid and drug molecules. Their low physical, chemical and photophysical properties impart unique attributes with implications in cancer diagnosis, bacterial diagnosis and drug delivery. However, the activity of an enzyme carried by the nanoparticle is lost when its secondary structure is lost.

Last fortnight, a research team from IISER, Bhopal in collaboration with IACS, Kolkata studied the enzymatic activity of α-chymotrypsin after binding to gold nanoclusters. They investigated whether α-chymotrypsin activity was restored after the addition of glutathione or oxidized glutathione.

The researchers used circular dichroism spectroscopy for analysing changes in the α-chymotrypsin structure. They observed that the α-chymotrypsin structure changed on binding to gold nanoclusters. Upon addition of glutathione or oxidized glutathione, α-chymotrypsin, freed from the surface of the gold nanoclusters, showed that enzyme activity was restored.

Matrix-assisted laser desorption/ionization mass spectroscopy showed that 10 mM glutathione or 5 mM oxidized glutathione restored lost activities of α-chymotrypsin in gold nanoclusters by 30–45%.

In cancer cells, elevated levels of glutathione could increase the effect of enzyme-coated gold clusters. The researchers suggest that this result may have implications in diagnosis, drug delivery and cancer treatment.

J. Colloid Interface Sci., **494:** 74–81

Terribly Tiny Tales

Silver nanoparticle toxicity

Silver nanoparticles are toxic to plants and human beings. To date, most research focuses on chemically synthesized silver nanoparticles and there is insufficient material discussing the toxic effects of biologically

reduced silver nanoparticles. To fill this lacuna, Gupta from the Indian Institute of Technology, Kharagpur, constructed silver nanoparticles using Chirata leaves and studied the toxicity of these biogenic silver nanoparticles on plants.

Chirata is a medicinally important plant with amarogentin and swertiamarin, constituents that can act as phytoreductants. When scientists incubated a solution of silver nitrate with Chirata leaf extract, the colourless solution turned brown in a few minutes signifying the synthesis of silver nanoparticles. The nanoparticles were then washed, separated and characterized through spectroscopic techniques.

The researchers found that the nanoparticles produced through this method were about 20 nm in diameter and had a crystalline nature as confirmed by transmission electron microscopy, atomic force spectroscopy and X-ray diffraction studies. Next, the scientists studied the toxicity of these nanoparticles on plants and compared it with that of chemically synthesized silver nanoparticles and ionic silver.

The results reveal that, when incubated for 4 hours, these nanoparticles could introduce chromosomal aberrations in onion root cells in a dose-dependent manner. The researchers noted genotoxic defects when pollen mother cells were incubated with the nanoparticles. The results from chemically synthesized silver nanoparticles and silver ions were similar. Biologically reduced nanoparticles were less toxic to mitotic cells. However, the results mimic those obtained when plants are incubated with silver ions.

Nanoparticles tend to accumulate in cells. Thus, they can affect plant growth, development and reproduction. To address this, the scientists suggest research on signal proteins and regulations on industrial practices to minimize the release of nanoparticles into the environment. The results also highlight the need for labs to formulate safety rules that take nanoparticle toxicity into account.

J. Hazardous Materials, **330:** 18–28

Breaking the Mould

Fungus for biofuel production

Sweet sorghum bagasse contains 75% carbohydrates and can be utilized for biofuel production. But a large part of these sugars remains trapped in a lignin network which reduces fermentable sugar yield. To solve this problem, scientists at the Dr B. R. A. National Institute of Technology, Punjab explored the possibility of using fungus variants to release unused carbohydrates by digesting lignin.

The research team collected sweet sorghum waste. They washed, dried and ground it to a fine powder. Based on existing literature on lignocellulolytic activity, the scientists accessed eight different fungal strains from microbial culture facilities. Then they tested these fungal strains on sorghum waste. They checked for lignin digesting enzyme activities, sugar release, and carbohydrate consumption. Of the eight strains tested, *Coriolus versicolor* turned out to be the most efficient in terms of lignin digested for every unit of carbohydrate consumed.

Since enzyme activity could be enhanced by certain metallic and non-metallic factors, scientists incubated a sorghum waste solution containing *C. versicolor* with different additives to identify the optimum culture composition for fermentable sugar production. The researchers found that a combination of syringic acid with copper sulphate exhibited maximum lignin digestion by the 20th day with a minimal loss in cellulose content.

FTIR spectrometry and X-ray diffraction studies confirmed a decrease in the crystallinity associated with biomass due to this treatment. The scientists noticed that this shift occurs due to enhanced enzyme activity that leads to greater utilization of hemicelluloses instead of cellulose. This, in turn, improves sugar extraction.

Use of the right fungus species increases lignin degradation almost two fold and improves fermentable sugar production almost five fold. With the addition of supplements, the system becomes twice as efficient. These are highly significant results and the scientists are confident that such combinations can make commercial scale fuel production from agricultural biomass attractive.

J. Environ. Manage., **193:** 558–566

Photocatalysts

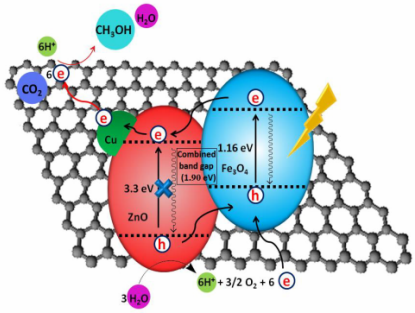
Reducing carbon dioxide

Carbon dioxide emission is increasing with the rise in consumption of fossil fuels. By converting carbon dioxide into useful hydrocarbons we can perhaps better protect the environment. This can be done with chemical, electrochemical, biological and photochemical means. Among these, a photochemical method that mimics photosynthesis has come into prominence recently.

Last fortnight, scientists from the Indian Institute of Petroleum, Dehradun reported the selective reduction of carbon dioxide using a heterogeneous photocatalyst.

Metal oxides such as TiO_2, ZnO, Fe_2O_3, rGO are transparent, have high specific surface area and light absorption capability. They arrange electronic structure with high mobility of charge carriers under stimulation with light energy. The research team examined the photoreduction of carbon dioxide with water to methanol, under visible light irradiation. They tested different combinations of graphene oxide and metal oxides under identical conditions. These were quantified with chemical and structural characterizations to improve photocatalytic performance. The team thus developed a multicomponent photocatalyst with a minimal quantity of graphene oxide wrapped in microspheres of $CuZnO@Fe_3O_4$. The core-shell structured composite – $rGO@CuZnO@Fe_3O_4$ – is effective

in the photoreduction of carbon dioxide with water splitting.



The product combines the higher surface area and electronic mobility provided by graphene, the magnetic property of ferric oxide and the eco-friendliness of zinc oxide to yield higher methanol. The photocatalyst was more efficient, recyclable and low-cost than existing catalysts. Biocompatibility and good mechanical strength are added benefits.

Appl. Catal. B, **205:** 654–665

Supercapacitors

Efficient storage devices

There are two types of high power density electrochemical energy storage devices or supercapacitors: electrical double layer capacitors or pseudocapacitors. Double layer capacitors use carbon materials whereas pseudocapacitors use transition metal oxides. The mechanisms and properties of these storage devices are, therefore, different. Double layer capacitors depend on ion adsorption and pseudocapacitors use redox reactions for storing electrical charges. Double layer capacitors have a longer cycle life while pseudo capacitors have high specific capacitance. For efficient storage and to maintain high power density, both qualities are essential. How can this be achieved?

Last fortnight, researchers from the Osmania University, Hyderabad, reported combining both qualities – high cycle life and high specific capacitance – in a new supercapacitor. They took two types of materials – one that is generally used in double layer capacitors and the other, in pseudocapacitors – to prepare a ternary composite. The team adopted an *in situ* chemical polymerisation method. And they deployed this composite as positive electrode in their supercapacitor. Such capacitors had both high specific capacitance and longer life cycle.

The specific capacitance of the device is 525 F/g, higher than that of double layer or of pseudocapacitors. The team attributes the high power density to the nano-structure of the composite.

J. Ind. Eng. Chem., **49:** 82–87

Synthetic Voice

Individuality of voice is an important aspect of personality. A voice conversion system plays with this to make one voice sound like another and even change the gender of a voice. This system finds application in audio dubbing, audition testing, audio-based learning tools, voice restoration, voice pathology, text-to-speech synthesis and security related matters. While retaining linguistic information, the system modifies various acoustic factors – frequency of utterance, and tone of speech – parameters that determine the quality and clarity of the converted voice.

Scientists from the KJS College of Engineering, Mumbai, the SVNIT Surat and the VJIT Mumbai, collaborated on a new algorithm-based method for better quality in voice conversion. They used two male and two female voices for intergender and intragender voice conversions. That gave four combinations for their conversions – male to male, male to female; female to female and female to male.

All four speakers uttered 70 sentences with similar linguistic information. The researchers used 40 utterances to extract acoustic parameters and 30 for voice conversion.

To evaluate the quality of the converted voice, and its match with the original voice, the scientists used two independent methods: mathematical calculations and assessment by 12 non-expert listeners. Both revealed acceptable quality that matches the original.

With the help of this technology, soon we may all be able to sing in Madonna's voice.

Neurocomputing, **237:** 39–49

Reports by: **Ashwathy Nair, H. M. Mahadeva Swamy, G. Sharath Chandra, A. C. Surya Prabha, Aditi Jain, Sarah Iqbal, Mridula Vellore, R. Baskar, Pavithra P. Nayak, Pudi Venkatesu** and **Neeta Shrivastava**

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Science Last Fortnight

Assessing Earthquakes

Making Kolkata safer

Kolkata stands on a seismically active zone. Old buildings rub shoulders with new structures, housing a dense population, amplifying the risk during earthquakes. The buildings here are constructed on thick deposits of the Bengal Basin's soft soils. These sedimentary deposits tend to liquefy under seismic stress. This liquefaction intensifies the degree of shaking and exposes the buildings to greater stresses. Thus, site-specific methods are required to understand soil behaviour under seismic conditions.

Scientists at the Jadavpur University, Kolkata recently developed a model for ground response analysis. This model estimates peak ground accelerations accurately for an earthquake at bedrock and surface level by simulating ground motions.

The team studied 144 locations across Kolkata and categorized them under 8 seismic subzones. They applied an artificial neural-network-based attenuation relationship model to analyse the seismic hazard of each subzone. And they used a response spectrum to report the interaction between ground acceleration and structure. The scientists included these spectral accelerations into the suggested model for analysis.

Specifications in the Bureau of Indian Standards, 2002, do not consider these local factors for designing buildings. Thus, structures constructed as per existing codes may undergo severe damage during an earthquake. Many Indian megacities are situated in the Ganga Basin. Such models can help reassess the risk of seismic damage to these areas as well.

J. Geophys. Eng., **14**(3): 466–477

Fly Ash in Embankments

Ticking seismic bomb

Fly ash is utilized as an alternative to natural soil for the construction of embankments. In a potential seismic zone, it can be risky as its dynamic properties are amplified during an earthquake. 'Pond ash mainly consists of noncohesive fine sand and silt. The material is vulnerable to liquefaction-induced failure', says Prishati Raychowdhury from the IIT, Kanpur.

Last week, his team of scientists reported the dynamic response analysis of a pond ash embankment near the Renusagar power plant in Uttar Pradesh, a Seismic Zone III, with moderate level of seismicity. The team experimentally validated and calibrated nonlinear material models of pond ash using finite element modelling.

They experimented with the dynamic characterization of the embankment in terms of mode shapes, natural period, acceleration amplification, horizontal and vertical displacement profile, nonlinear stress–strain behaviour, cyclic stress ratio, pore pressure generation and liquefaction potential. The researchers also characterized the pond ash using various laboratory tests, such as specific gravity test, sieve analysis, hydrometer analysis, standard Proctor test, consolidation test, and static consolidated undrained triaxial tests. They noticed a large amplification in horizontal as well as vertical displacement in pond ash.

In India, coal fuel based thermal power plants are a major source of power. And a large quantity of fly ash is produced. The researchers hope that 'policy interventions will be done by the Indian government regarding the disposal of fly ash for construction of embankments in seismically active areas'.

Int. J. Geomech., **17**(6): 04016141

Using Iron Ore Waste

To remove arsenic from water

Water is naturally contaminated with arsenic, a component of the earth's crust. Arsenic is mobilized into groundwater through the geochemical weathering of soil and biological actions. Chronic exposure to any form of arsenic leads to skin lesions and skin cancer. Existing techniques to remove arsenic from groundwater have inherent limitations. Nanofiltration membranes are attractive alternatives, but have high operating cost and fouling problems.

Last fortnight, Chatterjee and De from the Indian Institute of Technology, Kharagpur used inorganic additives in membranes to enhance selectivity for arsenic removal from groundwater. They took iron ore slime from steel industries and used it to impregnate a mixed matrix hollow fibre membrane made of polysulphone–polyvinylpyrrolidone.

The scientists assessed stability of the membrane using surface characterization, equilibrium studies and the dynamics of cross flow ultrafiltration of the membrane. Then they evaluated the arsenic removal efficiency of the membrane using groundwater from West Bengal, India.

Chemically treated iron ore slime decreased the permeability and porosity of the membrane, and improved the hydrophilicity as well as the arsenic removal capacity. Exhausted membrane was regenerated and used thrice. The dynamic filtration capability estimated for arsenic removal was reduced from 28 hours to 22 hours in the second regeneration and to 14 hours after the third cycle regeneration.

The membrane was also able to remove microorganisms and iron from real life feed solutions to below WHO approved permissible levels. Another example of how science finds ways to make industrial waste useful.

Sep. Purif. Technol., **179**: 357–368

Stopping Grain Drain

Gaining from plant peptides

The pulse beetle and the red flour beetle play havoc with stored grains causing heavy losses. Plants have evolved various mechanisms to fight insect pests. One of the primary strategies is to produce inhibitors of digestive enzymes such as amylase. If insects eat such plants they get indigestion because they are then unable to digest food.

But insects also evolve. Insects with a slightly different amylase that is not affected by the inhibitor survive and thrive on plants. And the plants respond by adjusting their inhibitor to the new amylase. Thus, there is now a diversity of inhibitors and amylases in the war between plants and insects.

This fight for survival using alpha amylase has gone on for millions of years. And *Amaranthus hypochondriacus* may have evolved the right inhibitor to throw the spanner into the digestive systems of the pulse beetle and the red flour beetle.

Scientists from the CSIR-NCL Pune, the Shivaji University and the North Maharashtra University, have now isolated the inhibitor gene coding for a peptide with 32 amino acids. Their studies show that it is cleaved out from a pro-peptide that is 75 amino-acids long in the golgi complex. The seeds of *Amaranthus* do not produce the peptide. It seems it is transported from leaves into the seeds and ultimately there is high concentration of the inhibitor in the seeds.

Thus, *Amaranthus* seeds or the inhibitory peptide can be used to develop products that deter insects from attacking our grains. Scientists find that *A. paniculatus*, *Celosia argentea* and *Achyranthes aspera* also have identical amylase inhibitors.

Their paper published last week provides important clues about the structure and function of the peptide. The first step to appropriate the plant's defenses to our purposes.

Plant Mol. Biol., **94**: 319–332

Mass Propagation of Soapnut Tree

Somatic embryogenesis

Long used as a traditional shampoo, the soapnut has now come into prominence as an environment friendly detergent. The fruits of the *Sapindus* tree are rich in bioactive compounds called saponins. The tree also yields other bioactive compounds. So products from this plant have been used to treat diseases like asthma, cholera, etc. Dye from the shell of the seed is used to colour shoe-creams, textiles and polishes. However, the high demand from the soap, dyeing and medical industries for soapnut remains unmet due to the slow growth of the plant and poor seed viability.

Last fortnight, P. Asthana and team, from the Banaras Hindu University, designed a new protocol for the mass propagation of the *Sapindus* plant through somatic embryogenesis. Using the sepal of the flower bud as explant, they developed embryos of the plant. The team studied the response of the explant on MS medium supplemented with varying concentrations of sugars and L-glutamine. And they observed a maximum number of embryos and secondary embryonic structures when the medium was supplemented with 200 mg l^{-1} of L-glutamine.

The scientists reported that 90% of the embryos they developed were acclimatized in the field. They claim that the technique is promising for the large scale production of *Sapindus* trees to meet industrial demand.

Ind. Crops Prod., **100**: 228–235

Contamination in Milk

Detecting kanamycin residue

Though milk has always been popular, there is increasing concern over the presence of contaminants. Antibiotics used in the dairy industry often surface as residue in milk. Kanamycin is one such antibiotic. Residual kanamycin in milk and other dairy products causes serious side effects, such as hearing and balance problems; it damages the kidneys.

Existing methods to detect kanamycin in milk, though sensitive and reliable, are time consuming and require high volumes of reagents. There is a need for simpler, faster, more robust, selective and specific methods to detect kanamycin.

Last fortnight, a research team from the Birla Institute of Technology & Science, Goa, the Université de Perpignan Via Domitia, France and the COMSATS Institute of Information Technology, Lahore, reported devising a simple, portable aptasensor, for the quantitative determination of kanamycin in milk.

The biosensor uses an aptamer, a short sequence of oligonucleotides with high affinity for kanamycin. The team used a kanamycin binding single strand DNA sequence to fabricate the sensor. This aptasensor was label free: it did not have any radioactive or fluorescent dye, metal complexes or nanoparticles.

The scientists claim that it is the first disposable and label free aptasensor for the detection of kanamycin without interference from competitive analogues. This kanamycin–aptasensor showed excellent recovery and the limit of detection was about 0.1 ng ml^{-1} kanamycin, meeting the requirement of regulatory standards. The results show that the sensor is simple and easy to use.

Sens. Actuat. B, **245**: 507–515

Reducing Salt Intake in Infants

Prevention is better than cure

Salt is ever present in food. Unfortunately, too much salt can result in hypertension, a major health problem worldwide. Though this health issue can be hereditary, bad food habits can predispose us to hypertension.

Researchers from the Institute for Indian Mother and Child, Kolkata collaborated with scientists in Italy to carry out studies in areas where hypertension is highly prevalent in both children and adults. They collected data from the mothers of more than five hundred infants aged 0–6.5 months. And information on the addition of salt in diet together with body weight from questionnaires filled by the mothers. They found that 90% of the mothers were breastfeeding and had healthy infants. However, most added salt in baby food after six months which resulted in low body weight and height. The team suggests that this high intake of salt is the reason for the higher incidences of hypertension in the population.

These results stress the need to educate mothers of the importance of breastfeeding and of postponing the use of salt in a baby's diet.

Int. J. Food Sci. Nutr., **68**(4): 467–472

Acacia Gum

Hydrogel for wound dressing

The gum of the acacia plant has been used medicinally for centuries. It acts as a demulcent, soothing mucosa. Thus, it is often applied to treat minor wounds.

Last fortnight, a research team from the Himachal Pradesh University, Shimla, used gum acacia to design a hydrogel for wound dressing. They prepared a hydrogel with acacia gum and polyvinylpyrollidone/carbopol. The team says that the rough surface morphology of the hydrogel film may help adherence to the healing tissue and allow cellular activity that promotes wound healing.

The researchers investigated the swelling behaviour of hydrogels and

report that swelling increased with increase in *N*-vinylpyrollidone content and then decreased. These trends may be due to increase in hydrophilicity initially. Later, increase in crosslinking reduces this effect. However, swelling increased with increasing carbopol content in the polymer matrix.

The hydrogel film is hemocompatible. The materials of the hydrogel are all highly hydrophilic and biocompatible. Hydrophilic surfaces show lesser adherence to the RBC membrane and therefore, less disruption of the cells. Thus, these hydrogel dressings can be regarded as safe for wound applications.

Gum acacia is known for anti-inflammatory properties. The oxygen permeability study for the hydrogel film showed that these films were permeable to oxygen. The antioxidative capacities of gum acacia can help scavenging excess free radicals. The polymer films showed antioxidant activity and absorbed wound fluids.

Using the microbial permeability test, the researchers showed that the hydrogel allows no microbial contamination. These wound dressings form a good barrier against microbes and prevent secondary infection during the wound healing.

Folding endurance test results show that hydrogel films are flexible and suitable for wound dressing applications.

The researchers tested the release of an antibiotic, moxifloxacin, from the hydrogel dressing and observed that it followed a non-Fickian diffusion mechanism. The results of the drug release studies indicate that these hydrogel dressings can deliver antibiotics in wound dressing applications.

Carbohydr. Poly., **165**: 294–303

Easy screening of *E. coli*

Mumbai. A hot Thursday morning. Mrs Sharma picks up the paper. The headline reads: *Cold shock: E. coli bacteria found in 92% ice samples in Mumbai*[1]. Would it not be nice if Mrs Sharma, like the billions who eat ice cream and enjoy a chilled drink, had an affordable, easy, and rapid method to detect faecal *E. coli* in the comfort of their homes?

Traditional methods of testing for *E. coli* contamination are long-drawn. In 2011, as part of the search for more rapid methods, Spanish scientists reported using nanoparticles modified by the antibiotic, colistin, to detect bacteria[2]. However, the method of synthesis of these nanoparticles is multistep – a major limitation in applicability.

Recently, S. K. Sahu from IIT Dhanbad and colleagues in Midnapore succeeded in achieving a ten-fold reduction in the number of steps required[3]. They used a new single-step pyrolysis method to synthesize colistin-modified carbon dots for the selective labelling, and thereby detection, of Gram-negative bacteria such as *E. coli*.

Briefly, they ground the carbon precursor for the carbon dots, diammonium hydrogen citrate, with varying amounts of the antibiotic, colistin sulphate, using a mortar and pestle. The obtained powder was then heated for an hour in a hot air oven. The final product was obtained by centrifugation and dialysis. Then, they tested their product for bacterial detection in urine and tap water samples.

Interestingly, the scientists also found that the synthesized carbon dots could be used to selectively detect Fe^{3+} in water, another issue that is garnering much attention.

These results are not just promising but also timely and have wide ramifications from in-time diagnosis of urinary tract infections to convenient detection of impure water using a simple kit. Mrs Sharma thinks that it's time to bring this technology to the market.

[1]*The Hindustan Times*, 2 June 2016
[2]*Biosens. Bioelectr.*, **26**(11): 4368–4374
[3]*Sens. Actuat. B*, **245**: 835–844

Microfluidic Chip
For blood analysis and cell sorting

Complete blood count is commonly required for various diagnostic and prognostic purposes. Currently, a flow cytometric instrument, with costly optics and electronic components, is used for these tests. Such equipment occupies significant laboratory space. Lots of blood is required for processing. All this increases cost and time.

To tackle these issues, scientists from IIT Hyderabad, in collaboration with the Michigan University, developed a portable device: a centrifugal microfluidics chip. They mixed blood with ficoll in the central microchannel on a chip. On single centrifugation of 10 min, ficoll separates different cells from blood according to their density gradient. The separated cells get sorted into microchannels positioned to collect the specific cells at their point of separation. This process provides recovery and purity rates >95% for peripheral blood mononuclear cells and a viability rate of 98% for recovered WBCs.

These isolated cells can be used for downstream culture applications and single cell analysis. *In situ* fluorescence staining and 4-colour immunostaining can also be done. Multicolour imaging and analysis of the sorted immune cells can be done in minutes. The device also provides clean cell free plasma for various biomarker analyses.

This chip requires as little as 250 microlitres of blood, far less than the currently used volume. The device also requires mere nanolitres of reagents, reducing cost per run. Further, miniaturization lowers sample processing time, and cuts down on manual errors associated with earlier methods. This compact and ready-to-use 'lab-on-a-chip' is a boon for point-of-care blood-based diagnostics and prognostics testing. It would also benefit cell biology and biomedical researchers. High precision, simplicity of design, and cost effectiveness for blood cell sorting and *in situ* analysis, make this portable device an asset to your lab.

Sens. Actuat. B, **245**: 1050–1061

Gold Nanoparticles
Treating breast cancer

Chemotherapy remains the major treatment for breast cancer. Antioxidants and cytotoxic drugs target cancerous cells in this therapy. However, it is expensive and damages healthy cells too. Recently, metal nanoparticles, including gold nanoparticles, were mooted as alternatives for cancer therapy. However, chemically synthesized gold nanoparticles are not biocompatible.

Recent reports show that biomolecules, such as proteins, phenols and flavonoids from plants, can be used for capping metal nanoparticles to reduce toxicity. Plant-based nanoparticle synthesis is cost-effective and the products are biocompatible. Last fortnight, Ramkumar and team from the Periyar University, Salem used non-toxic gold

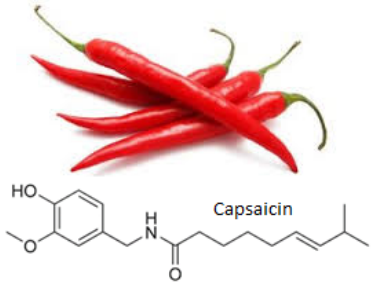
nanoparticles from a common weed, *Lantana camara*.

They found that root extracts from the plant can be used to encapsulate gold particles. Capped with the plant extract, the nanoparticles showed significant antioxidant and cytotoxic properties. These biologically synthesized nanoparticles proved more effective than chemically synthesized nanoparticles and can be low-cost alternatives as anticancer drugs.

Artif. Cells Nanomed. Biotech., **45**(4): 748–757

Seasonal Allergy
A chilli cure

We all have experienced the pungency of chillies. Capsaicin is the chemical which makes chilli pungent. Capsaicin binds to the pain receptors of the tongue and causes a burning sensation which the brain interprets as hot and spicy. Though we use chillies every day, few know of its use as medicine. It also enhances the curative effect of other medicines. A team of scientists led by Bedada from the Kakatiya University, Warangal studied this unique property.



They used capsaicin with fexofenadine, used for seasonal allergies, to examine the bioavailability of the drug for producing a curative effect. When given orally, the bioavailability of this drug is poor. Bedada and team used animal experiments to show that, when fexofenadine is administered in the presence of capsaicin, its absorption and concentration in the body is enhanced 2–3 fold.

This drug–diet interaction can help doctors tailor dosage to food to enhance cure.

Capsaicin, as chilli, is part of our daily diet. This may alter the effects of medicines. More research on drug–diet interaction is required for other drugs as well. However, for seasonal allergies, it is a chilli cure!

Drug Dev. Ind. Pharm., **43**(6): 932–938

Spice Nanoemulsions
Safer antimicrobials

Fresh fruits and vegetables top the list when it comes to healthy eating. Paradoxically, they can cause food-borne illnesses since they are vulnerable to microbial contamination. Preserving fresh produce for longer has always been a challenge in the food industry. A common method for preservation consists in washing with a solution of chlorine bleach in water to kill germs. However, toxic chlorine by-products raise issues related to safety for health.

Recently, researchers from the Pondicherry Central University came up with a solution: cumin and pepper oil nanoemulsions. To create nanoemulsions of the spice oils, they mixed essential oil, a detergent solution and water. And homogenized the mixture using ultrasonication.

When the researchers tested the spice oil nanoemulsions against *E. coli* and *Salmonella* species from fresh fruits and vegetables, they found that the nanoemulsions exhibited inhibitory effects on bacterial growth and motility. The emulsion could also affect the bacteria's ability to form biofilms. That means they become less pathogenic!

The researchers then checked whether these nanoemulsions could affect quorum sensing in bacterial populations. Quorum sensing is a bacterial collaboration mechanism where the cells collaborate to bring about a certain action, such as pathogenicity. The researchers found that the nanoemulsions are potent quorum quenchers!

Overall, the cumin oil nanoemulsion proved a better antimicrobial agent than the pepper oil nanoemulsion. But what the study truly demonstrated is that the potential of spice oil nanoemulsions as a natural alternative to chemical antimicrobial agents warrants further investigations.

LWT-Food Sci. Technol., **79**: 152–159

Castor stalk
Source for cellulose fibres

Cellulose, the most available organic matter on earth, is a major source of fibre for textile applications. Globally, farming generates tonnes of agricultural wastes containing substantial amounts of cellulose in fibrous form. Farmers would benefit economically if we could extract fibres from such waste.

The most well-known plant-based fibres are cotton, flax and hemp. Fibres from bamboo, banana and ramie are also popular, readily available and inexpensive. Now, a research team from the Jyothy Institute of Technology and SKSJTI, Bengaluru suggests the use of castor plant residues as a source for fibres.

The research team used an alkaline approach to extract castor fibres. Treating with alkali removes most non-cellulosic substances leaving only fibre bundles. The team found that, morphologically, individual castor fibres show convolutions and fibrillar architecture similar to cotton. The tensile property of castor fibres is similar to that of other natural fibres. These fibres have high fineness and low resistance to bending. So fabric from castor fibre will be less stiff.

Elongation of the fibres at 5% was higher than for common bast fibres such as jute and flax. As fibre fineness increases, torsional rigidity reduces proportionally. Fibres can be twisted easily during spinning. Thus, castor can be processed as textile fibres.

The researchers reinforced castor fibres with polypropylene and made composite fibres. They found that castor fibres are suitable as reinforcement for composites. Fibres and composites developed using castor are similar to, or better than, cotton and jute fibres. Thus, castor has potential in the production of bio-composites also.

Ind. Crops Prod., **100**: 126–131

Reports by: **Nivedita Mishra, Pinky Raychaudhuri, Shama Aphale, Pudi Venkatesu, Savitha Sekhar, Neeta Shrivastava, H. M. Mahadeva Swamy, Aditi Jain, Jinsu Varghese, R. Baskar, V. Subashini** and **P. Vijisha**
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Science Last Fortnight

Fighting Fungal Infections

A step towards finding the targets

Fungal organisms, especially pathogens, change their vegetative morphology reversibly between unicellular yeast and hypha for survival and proliferation in the host environment. Therefore, it is important to understand the molecular events involved in the morphological transition to target them at a biochemical level for developing different antifungal agents.

Mukund Deshpande at the CSIR-NCL, Pune, focused his attention on understanding the mechanism driving the yeast-hypha reversible transition using *Benjaminiella poitrasii*, a zygomycetous fungus, as model. This fungus produces yeast and hyphal-form cells in the vegetative phase while sporangiospores and zygospores are produced in the asexual and sexual phases. It shows a yeast-hypha transition in response to factors such as temperature, pH, glucose in the medium, etc. just like human pathogenic dimorphic fungi. But it is a non-pathogenic fungus – so safer to work with!

Ejaj Pathan, his student, started screening for morpho-genes, the molecular switches that determine the dimorphism of *Benjaminiella poitrasii*. However, to identify the correct morpho-genes, it is necessary to have the set of dependable reference genes that do not change their expression in the dimorphic transformations.

The team, along with Vandana Ghormade from the Agharkar Research Institute, Pune, has now published a paper that screened a set of 13 genes to check their potential as reference genes to understand the role of morpho-genes in *B. poitrasii*. Out of these, they identified two most stably expressed genes to normalize the expression of ornithine decarboxylase, an important biochemical correlate of the morphological transition. And this, in a way, confirmed that these two genes can be used as reference genes in the morphological transitions.

Now, drug designers can use these two reference genes to easily identify all morpho-genes and target them to block morphological transitions. A significant step in the search for better anti-fungals.

PLoS ONE, **12**(6): e0179454

Hope Springs from Hot Springs

New lead for tuberculosis

Tuberculosis has resurfaced as a life threatening disease. Existing drugs are failing as overuse has led to drug-resistant strains of the pathogens. There is a dire need for new anti-tuberculosis formulations and scaffolds.

Though researchers have isolated microbes from all kinds of extreme conditions, those from hot springs are only recently gaining attention. Hot springs house microorganisms which secrete antimicrobial compounds.

Recently, in a review, researchers from the Research Centre of Piramal Enterprises Limited, Mumbai, reported isolating an anti-tubercular compound, Fusaricidin B, from *Paenibacillus polymyxa* strains. They stumbled upon this eubacterial species while screening for microbes in soil samples around hot springs, in the Uttarkashi district of Uttarakhand.

They identified a compound, MDR-TB, active against tuberculosis. Though the findings are promising, more studies are required to assess the efficacy and safety of the compound before it can be marketed to tackle tuberculosis.

Biochemical Pharmacology, **134**: 35–41

Multiple Diseases, One Drug

A National Institute of Health 2002 report claims that 80% of microbes form biofilms in infecting their hosts. The biofilms are persistent surface-attached microbial communities. They protect the bacterial population by preventing the entry of antibiotics, leading to high morbidity and mortality in hospitalized patients. Scientists are therefore searching for therapeutic agents to control biofilm formation.

Last fortnight, researchers from the Aligarh Muslim University, in collaboration with the National Institute of Immunology, New Delhi, reported developing a nano-conjugate to prevent biofilm formation: undecyl-chitosan. They synthesized this compound by coupling an amine group of chitosan to a carboxyl group of fatty acids. Chitosan is a natural cationic polysaccharide and, in a modified form, a bacteriostatic. It is non-toxic and biodegradable. So it has been used as nanomaterial in many biological applications. The fatty acids attached to chitosan allow its entry into the biofilm to suppress bacterial growth.

The researchers tested the effect of this nano-conjugate and found that it can efficiently penetrate thick layers of biofilm and achieves 98% disruption of the biofilm, by killing the associated bacteria. The conjugate also showed broad-spectrum antibacterial activity against many Gram-positive and Gram-negative bacteria.

Unsaturated fatty acids destroy cancer cells by inducing apoptosis. So such conjugates can be designed to destroy cancer cells, without affecting healthy cells.

Humans are prone to many diseases and various drugs are sometimes administered together to cure different diseases. These drugs interact inside the body and this can produce side effects. One treatment to cure multiple diseases seems a need of the times. This nano-bioconjugate might hold hope to cure many bacterial diseases by overcoming the barrier of biofilms while preventing cancer.

Carbohydr. Polym., **166**: 14–23

Chromium Removal from Water

Eco-friendly hybrid membrane

Hexavalent chromium in wastewaters is a hazard to human and environmental health. Now, Geetha Balakrishnan, Mahesh Padaki and other scientists from the Jain University, Bengaluru, in collaboration with scientists from Thailand, report having successfully developed an eco-friendly hybrid membrane to help remove chromium from water. This membrane can also photocatalytically reduce hexavalent chromium to Cr(III). Incidentally, Cr(III) is required in trace amounts for human health.

The researchers used hydrophobic polysulphone, converting it into a hydrophilic polymer by sulphonation. They made it into a composite, incorporating nano titania. Thus, the toxic water is exposed to photoactive TiO_2 which reduces Cr(VI) to Cr(III). The addition of nanofillers improved membrane performance and application. The scientists evaluated the performance of the membranes on the basis of selectivity and time taken for separation. These parameters can be tuned by choosing the right monomer for the polymer or by surface modification of the membrane.

The researchers used spectroscopic and microscopic techniques to characterize the properties of the modified polymer and its composites. The scientists evaluated the performance according to water uptake, contact angle, pure water flux and ion exchange capacity. Their results demonstrate that the composite membranes have enhanced hydrophilicity and flux.

This hybrid membrane reduced Cr (VI) from the concentrated feed completely and photochemically converted it to Cr (III) with good selectivity and productivity. Such an efficient method to separate, reduce, and recover chromium would go a long way to protect humans and the environment.

J. Haz. Mat., **332**: 112–123

Dhapa Landfill Near Kolkata

Predicting arsenic contamination

Dhapa, on the outskirts of Kolkata, is the city's dumping ground. Around 3000 tonnes of solid waste are disposed off daily here. Hazardous materials are often found in these garbage dumps – even those that are banned from open disposal. Including arsenic, present in many solid wastes, from many industrial processes. Its accumulation leads to soil degradation and the land loses natural, agricultural and economic value. Inorganic arsenic from these contaminated soils pollutes adjoining water bodies. It is toxic and carcinogenic.

Bangladesh and West Bengal already suffer soil arsenic contamination. Is the dumping ground adding fuel to fire?

Somsubhra Chakraborty and team from the Indian Institute of Technology, Kharagpur suggests the use of Visible Near Infrared Diffuse Reflectance Spectroscopy for the rapid and cost-effective analysis of soil solid arsenic phases. They claim that it can help study polluted soils.

The scientists collected 200 soil samples from arable land adjoining the Dhapa landfill, where vegetables like cauliflower, ridge gourd and corn are cultivated and supplied to the city regularly.

http://images.indianexpress.com/2016/02/dhapa-dumping-759.jpg

The arsenic pools selected for this research study are associated with several organic and inorganic constituents of soil. So they implemented a model with a Partial Least Squares Regression algorithm in combination with three spectral pre-treatments to predict arsenic as well as five distinct arsenic pools: organic, phosphate, oxide, hydrochloride, magnesium. And they independently validated the results. They find that they can predict redox-dependent solid arsenic phases comprising oxides and sulphides reasonably well using Visible Near Infrared Diffuse Reflectance Spectroscopy. It is fast and works for the simultaneous prediction of easily mobilized and adsorbed arsenic pools in the soil.

Existing methods of soil analysis for arsenic are strenuous, expensive, and time consuming. The Visible Near Infrared Diffuse Reflectance Spectroscopy method for arsenic prediction is faster and more cost-effective. It also has the potential to rapidly screen many soil samples for other solid arsenic phases in broader geographic areas.

Geoderma, **296**: 30–37

Flip Side of Cyanide

Safe and precise monitoring

The word 'cyanide' spells danger to most. The bioaccumulation and biodegradation of this toxic substance pose a threat to human health and the environment. On the flip side, however, it plays a significant role in gold mining, tanning and electroplating.

Hydrogen cyanide, the most common form of cyanide in nature, is released into the atmosphere by the natural biogenic processes of higher plants, bacteria, fungi, etc. Of these, plants are the most significant cyanogens. Sorghum leaves produce about 192–1250 µg/g of cyanide. Other plants such as cassava, peach, pear, almond, potato, and plum are also highly cyanogenic. The most common form, cyanogenic glycoside, is present in over 2000 species of plants. The cyanide cycle in nature is linked to the nitrogen cycle.

A major part of the cyanide absorbed in the human body reacts with thiosulphate and converts it into thiocyanate, which is harmlessly excreted in urine over time. However, exposure to more than 120 mg/m^3 cyanide is dangerous and even fatal. Toxic effects occur at 0.05 mg/dl in blood. Unfortunately, there is, as yet, no sensitive and selective chemosensor to detect this toxic compound.

Now, Kuwar and other scientists from IIT, Mumbai; NMU, Jalgaon; SVNIT, Surat report designing and synthesizing a new biocompatible, reversible receptor for the online monitoring of cyanide ions in environmental and biological systems.

The researchers synthesized a supramolecular optical chemosensor using diaminomaleonitrile and benzothiazole. This is a dual purpose reversible abiotic molecular device which uses hydrogen bonds to bind cyanide and produces a change in light absorption and fluorescence.

The chemosensor is selective to cyanide ions even in the presence of other anions. The researchers used L292 cell lines to demonstrate that the sensor can be used to detect cyanide ions in biological systems without any toxic effect.

This supramolecular device will help environmentalists and biochemists monitor small amounts of cyanide ions entering a system. The reversible nature

of the chemosensor makes monitoring economic, safe and precise.

Biosensors & Bioelectronics, **92**: 95–100

Bioactive Fruit Wastes

From dumping to development

India, fruit basket of the world, is a major contributor of waste worldwide. Fruit wastes are rich in bioactive compounds such as pectin, lipids and dietary fibres. The solid remains and seed fractions of fruit processing wastes can be refined to extract many valuable chemicals. After extracting the chemicals, the wastes can be used to produce biofuels and biofertilisers. However, in practice, fruit waste is generally considered 'general waste' and discarded. Fruit processing industries use it as landfill where it contributes to pollution. Since it is rich in nutrients and moisture, it fosters microbial growth. Recent studies show that fruit wastes are a major environmental burden.

Last fortnight, scientists from the IIT Bombay and the Monash University, Australia, proposed an eco-friendly and economic model of a biorefinery for using fruit wastes. Their goal was to use this waste as starting material for the recovery and production of various co-products.

Lipids and proteins, derived in the first stage, can be used as polymers in pharmaceuticals. And the bioactive polyphenols are used as preservatives in the food and pharmaceutical industries. Recently, they have also attracted the attention of cosmetics manufacturers. Dietary fibres find value as nutritional supplement for hypertension, obesity and in antidiabetic formulations. The residue, rich in carbohydrates, can be used for the production of biofuels.

The scientists did a techno-economic evaluation to show that extraction of bioactives from fruit wastes is economically more sustainable than the traditional solid–liquid extraction methods. It consumes less energy and extracts useful products faster.

Developing countries, accustomed to use fruit processing wastes only as soil improvement additive, can now tap the potential of such waste to transform their economies.

Food Chem., **225**: 10–22

Nano Globules from Pineapple Juice

Detecting toxic metal ions

Most existing methods for detecting toxic metal ions lack the requisite sensitivity and are time-consuming. To easily detect toxic metals with high sensitivity and stability, several nanomaterials have recently been developed. Recently, S. K. Kansal and team from the Punjab University, Chandigarh, along with scientists from Saudi Arabia, reported a new candidate material: carbon nano globules from pineapple juice.

They used a simple one-step hydrothermal process to synthesize the carbon nano globules from pineapple juice. They used various analytical and spectroscopic techniques to determine the structural, morphological, thermal and optical properties of the carbon nano globules. The globules had a spongy structure and exhibited fluorescence.

They claim that fluorescent carbon nano globules from pineapple can be used as a probe to detect several hazardous metal ions, particularly chromium hexavalent ions. These nano globules drastically quenched hexavalent chromium ions with high selectivity over a range of concentrations. They are highly stable and can be used to fabricate biosensors to detect hazardous metals with ease.

This alternative means of monitoring toxic chromium ions is eco-friendly, cost effective and the raw material is readily available. It can be used for analytical, toxicological and bioremediation purposes.

Ceramics Int., **43**(9): 7011–7019

Super Hydrophilic Surface

Water does not wet the lotus leaf. Why?

Because the surface contact angle between water and leaf is high.

If the contact angle becomes zero, liquid sticks to the surface strongly making the surface super hydrophilic.

This principle has applications in solar energy conversion, heat transfer, gas sensors and anti-fogging coatings.

Last fortnight, Prakash and team, from the Pondicherry University fabricated zero contact angle surfaces by using the effects of UV illumination on the surface of titanium.

First, they used electrochemical surface modification and optimized the contact angle of the titanium surface to 3.25 degrees. Then, they coated the surface with titanium dioxide nanoparticles and that changed its hydrophilicity: the contact angle increased to 5.63 degrees. The researchers then used UV radiation to reduce the contact angle to zero.

According to the scientists, this super hydrophilicity is not only due to a reduction in contact angle but also the porous nature of the surface. Both play a critical role to increase hydrophilicity.

The scientists used a composite-drop theoretical model to deduce the interrelationship between the surface structural factors that influenced the super hydrophilic surfaces. This approach can help optimize thermal hydraulic and self-cleaning surfaces. A trick that many industries are looking for.

J. Colloid Interface Sci., **496**: 300–310

Gel Electrolytes for Solar Cells

Absorbing light from both sides

Dye-sensitized solar cells are the next big step in solar technology. The dye coats the surface of titanium dioxide (TiO_2) nanoparticles, mimics plant chlorophyll in absorbing light energy and converting it into a flow of electrons. The existing models use liquid electrolytes to allow better mobility. But they have stability issues due to evaporation. Solid-state electrolytes show better stability but register lower efficiency.

A team of scientists from the National Institute of Technology, Trichy, Karaikudi and collaborators from Italy made progress to improve efficiency and stability. The group focused on the electrolytes of the dye-sensitized cells. The electrolytes carry the charged particles to the counter electrodes. Thus, tweaking the electrolytes may help improve the performance of dye solar cells. Liquid electrolytes can be trapped in a polymer matrix as gelators. Gel polymer electrolytes, in between solid and liquid, have the advantages of both liquid and solid-state electrolytes. This helps retain the

conductivity of liquids and the stability of solids. Thus, gel electrolytes result in better efficiencies of the solar cells.

The scientists prepared a transparent gel electrolyte by incorporating thiourea, a not-so-distant derivative of urea, into a polymer of ethylene oxide. This improved the ionic conductivity and photovoltaic efficiency of the gel.

The dye-sensitized solar cells are bifacial: they can use light from both sides of the solar cell. Transparent solar cells have potential application in photovoltaic-like power generating windows that continue to work at night when you switch on lights inside the room. Further, the transparent cells can be coated with dyes of different colours to give an aesthetic feel.

J. Power Sources, **353**: 245–253

The Perfect Mix

Cement technology bolsters real estate, roads, railways and public structures. This ever growing sector propels a search for better concrete mixes. This has led to the production of high performance cement called Reactive Performance Cement or RPC. RPC has low water to cement ratio, greater binding strength, higher density and better resistance to corrosion. There are various ways of mixing cement, sand, quartz powder, silica, steel fibres, etc. to yield different types/strengths of RPC. These approaches are often indigenous and do not follow any particular methodology.

Last fortnight, Parameshwar N. Hiremath and Subhash C. Yaragal from the National Institute of Technology Karnataka, Surathkal, reported optimizing mixing methods for RPC. The mixing method, speed and duration affect the quality of RPC produced and its properties after hardening. They propose a four-stage sequential mixing of cement and silica fume, sand and quartz powder, and then water.

The scientists optimized speeds to produce a fresh mix of high quality RPC in the shortest time. They claim that this method produces RPC with better flow, strength and denser microstructure. Thus, it resolves issues in existing methods of preparing RPC.

This methodology is yet another feather in the cap of Indian scientists working on cement technology. It is economic and eco-friendly and promises to reduce civil engineering costs and benefit stakeholders.

Construct. Build. Mat., **141**: 271–288

Crossing Lingual Boundaries

A new method for text detection

Separating text from the scenery in photographic images automatically is not simple. If there are scripts of different languages and they have different orientations, the problem becomes even more complicated.

Last fortnight, researchers from the Indian Statistical Institute, Kolkata, the University of Malaya, the Nanjing University, China and the University of Mysore, Karnataka, reported a simple method for text detection from images of natural scenes. They used ring radius transform to achieve this. The method provides low radius values for pixels that are near edges, constant radius values for pixels that represent stroke width, and high radius values that represent holes created in the background as well as convex hull because of the regular structures of text components. They also applied k-means clustering on the radius matrices to group such spatially coherent regions into individual clusters. The scientists successfully used this method to separate Chinese, Bangla and English texts from a natural scene image.

They claim that this method of text detection can be applied to other multilingual scripts and plan to increase its sensitivity for text detection.

Neurocomputing, **242**: 96–112

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